Nature

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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THURSDAY, MAY 5, 1904.

THE METALLURGY OF STEEL.

The Metallurgy of Steel. By F. W. Harbord, A.R.S.M., F.I.C. With a Section on the Mechanical Treatment of Steel by J. W. Hall, A.M.Inst.C.E. Pp. xxiv+758. (London: Charles Griffin and Co., Ltd.) Price 25s. net.

A PONDEROUS volume, profusely illustrated, abounding in detail, probably the best yet published on the whole subject, yet a little disappointing, for, though necessarily to a large extent a compilation, it lacks more than need be that personal touch of the author in selection and presentation which the student so much appreciates. Such is the feeling left by a careful reading of the work. The subject is taken in four parts:—(1) the manufacture of steel; (2) reheating; (3) the mechanical treatment of steel; (4) finished steel. It inspires confidence that the author as a metallurgist has induced the well known metallurgical engineer, Mr. J. W. Hall, to write part iii., and to join with him in the chapter on reheating.

The Bessemer processes, acid and basic, and all their modifications are very well described, and illustrations of various historically interesting as well as typical modern forms of converter are given, in many cases as working drawings with dimensions. The small converters for surface blowing have a special chapter to themselves, and the best known forms are described. It is well that it is so, for they bid fair to revive a little the fading glories of the Bessemer process by their suitability for the making of steel for castings.

The general scheme adopted is to describe the apparatus, then the process, next the reactions of the process, and lastly the thermochemistry, a method which involves some repetition but makes reference easy. The open hearth is similarly treated, such special furnaces as the Siemens new form, the Campbell, and the Wellman tilting furnaces being illustrated in great detail by means of folding plates.

The somewhat sensational Talbot process is carefully considered with the author's special facilities for exact knowledge in this matter. The chapter on steel castings is disappointing, and will serve to illustrate the feeling mentioned above. Few will admit that the beneficial effect of silicon and manganese on castings is due to their removing oxidising gases, or that aluminium in the quantities used increases the fluidity or removes the dissolved oxide of iron. The statement that annealing hard castings counteracts their tendency to fly when cooling is obscure, while the full table of Prof. Arnold's recent results on castings is given without any warning that these results are the basis of a research series, and that the steels are not suitable for commercial work, a point most clearly stated in the original. The weight of Prof. Arnold's authority on practical matters, combined with the relative space taken up by the table, will certainly tend to mislead the student here. The chapter finishes with three tables of three, two and two tests respectively, showing the effect of annealing, &c., yet from a remark in the text, the last two appear to be forgings.

The chapter on crucible steel is difficult to estimate, as to anyone acquainted with the innermost workings of the old crucible steel trade, with its meagre literature, it is almost impossible to judge as to how much a writer might reasonably be expected to know. To the general reader it will be sufficiently interesting, while the beginner in a works could point out many flaws. On entering the gate on a morning the author would find that blister bar is not "cut up," but broken with a hand hammer, giving out quite a musical series of notes as the bars become shorter. The crucible shown would be difficult of manipulation by "the teemer," the real "Sheffield pot" having a well designed and quite artistic shape. The sulphur does increase in melting, and a careful watch must be kept on the quality of the coke, or the rise will be serious, even in high carbon steels, where the carbon, according to the author, expels the sulphur, which somehow in practice it fails to do. The increase of phosphorus, if any, is not detected in ordinary working.

In part iii., on the mechanical treatment of steel, by Mr. J. W. Hall, the excursions into theoretical matters of pure metallurgy are not always happy, but the other parts are treated as one would expect from an engineer of his enthusiasm and experience. The development of various types of mills, examples of modern plant, forging by the hammer and by the press, all seem excellently treated, while the case for and against fluid compression is made very clear. Several Sheffield firms, however, make high speed steels, generally acknowledged to be much more than "nearly equal to those at Bethlehem."

Part iv., by Mr. Harbord, on finished steel, treats of the metal steel itself, its mechanical properties, the relations of iron and carbon, influence of other elements, effect of heat treatment, and the microscopical examination of steel. Mechanical testing makes a good chapter, but why use the erroneous term "tensile strain" instead of "maximum stress"?

To the chapter on iron and carbon many will eagerly turn, because of the paramount importance of the subject in everyday work, its great historical interest, and it may be also because of recent controversy. Perhaps, therefore, one expects too much, but it must be confessed that the author does not seem to have risen to the occasion, and gives only a not too excellent compilation where one expected a sorting out and a grappling with the question. The well known diamond and iron *in vacuo* experiment is taken as proof that carbon can be transferred to iron without the intervention of gas, whereas it is now well known that steel which has ceased to give off gas even at 1000° C. will give off more if heated to 1200° C. After a description of temper (or annealing) carbon, "the existence of this form of carbon has not been confirmed by other investigators" is a rather startling statement. The research on "The Influence of Carbon on Iron," published by Prof. Arnold in 1895, and acknowledged by all to be a classic, is quoted, and with it some recent work of the author's own which only seems to obscure the subject. The author hardly deals fairly with his readers in withholding the tests of his steels as received, and the first three are given here (see sixth report Alloys Research Committee) side by side with ordinary commercial samples taken at random. It will be clear that they are a very undesirable series as a basis for such a research. The three numbers represent maximum stress in tons per square inch, elongation per cent. on two inches, and reduction of area per cent. respectively:—

Harbord ...	30	20	35	Harbord ...	33	13	25
Commercial	30	30	60	Commercial	35	28	47
Harbord ...	31	13	30	Harbord ...	37	6·3	19

The author seems almost alone at the present date in the opinion that "hardening carbon is possibly merely free carbon dissolved in iron," as even Stansfield, Osmond and Stead all favour the idea of carbide dissolved in iron, and the author ought to have told his readers this. He also says that the carbon theory does not explain the critical points in pure iron and loss of magnetism, but surely he must know that the main function of the carbon theory is to explain the hardening of steel. He is hardly up to date on some important matters, as he takes Arnold's mere suggestion of long ago as to Ar_3, and leaves the student to think that this is the present well defined position, whereas both sides are agreed as to Ar_1 being the real carbon change point, and to carbonists it represents the formation or decomposition of a substance corresponding to the formula $Fe_{24}C$. All are agreed also that the purest iron shows Ar_3 and Ar_2, and Prof. Arnold's theory with regard to Ar_2 is quite sufficient to account for the disappearance of magnetism. The author should remember that the serious question is this, "Does a flint hard allotropic iron exist?" The allotropists are more happy than the carbonists in that they have a crisp explanation for Ar_3, if the use of another Greek letter as a prefix can be said to give satisfaction to any practical worker in the field. The solution theory is given in detail, but the author wisely dismisses the application of the phase rule to the problems of steel by reference to original papers, and the student who endeavours to follow these is in need of sympathy if he be well acquainted with the known facts.

The extremely difficult subject of the influence of various elements on steels is well considered, but the author implies that Le Chatelier was the pioneer in our knowledge of sulphide in steel, while everyone should know that that honour belongs to Prof. Arnold. Heat treatment of steel is discussed in twenty-seven pages, and the last chapter deals with the microscopical examination of steel, and several methods of preparation and etching are well described, but Fig. 448 should either be altered to suit opaque objects or removed.

The volume closes with 100 photomicrographs, four useful appendices, and a good index. The structures shown in several of the photomicrographs are not in accord with the writer's experience, but that might be due to abnormal crystallisation in the original steels, which seem to be identical with those used for the sixth report already mentioned. Several errors have been noted, but there is only room to indicate a few as examples:—p. 53, "wild metal which pipes in the moulds"; p. 101, incorrect definition of a heat unit; p. 227, the hardening power of liquids is said to be a function of their specific heats, whereas their conductivities are more important, as witness mercury compared with water; "microphotograph" all through the work instead of photomicrograph. On p. 680 0·8 carbon steel is indicated as saturated, while on p. 681 it is 0·9, and the footnote to p. 684, "The latest research has shown that it should be 0·9," gives a wrong impression. It had no need to be shown after 1895, as Arnold made it quite clear then, and others, perhaps working on impure steels, claimed 0·8, but now they have seen their error and 0·9 is accepted almost universally. On the whole, however, the book is to be recommended as the best available on the metallurgy of steel.

A. McWILLIAM.

FROM THE ANGLER'S POINT OF VIEW.

Trout Fishing. By W. Earl Hodgson. Pp. xviii + 276. (London: A. and C. Black, 1904.) Price 7s. 6d. net.

Fishing Holidays. By Stephen Gwynn. Pp. ix + 299. (London: Macmillan and Co., Ltd., 1904.) Price 7s. 6d. net.

An Angler's Year. By Charles S. Patterson. Pp. xii + 192. (London: W. R. Russell and Co., Ltd., n.d.) Price 2s. 6d.

THE first two of these books are not in any sense books of reference or guides for the angler; Mr. Gwynn frankly states that his object is not instruction but amusement, but it is no ground of complaint that the former as well as the latter is to be found in his descriptions of his fishing holidays. Mr. Hodgson's is a pleasantly trivial book, interesting as giving the views of an experienced fisherman on many points, but no more instructive, in fact, than Mr. Gwynn's in intention. The former is at his best when describing matters of his own observation; "the whustler" would take a lot of beating as a piece of pure narrative, and is almost on a level with Mr. Gwynn's best; it calls for equal admiration in the vigour with which an almost Homeric battle is described, and the delicacy with which a veil is drawn over the undignified end of a noble fish, but it is scarcely possible to extend this admiration to the delicacy with which twenty-one of the author's friends and a daily newspaper are veiled in the obscurity of initialled dashes, which are frequently inadequate as a disguise and always typographically unsightly.

Mr. Hodgson deserves great praise for his effort to figure adequately in colours a series of trout flies, and the result is really very pleasing; we wish we could add really successful, but it seems very doubtful whether the three-colour process is suited to this class of work; the reds, and especially the clarets, are not satisfactory, and a comparison of the different representations given of, *e.g.*, the cow-dung, olive dun, or black gnat seems to show that sufficient accuracy for work of this nature cannot be obtained by the process employed. The excellent reproduction of a picture of a group of brown trout given as a frontispiece may almost serve as a contrast to the figures of flies to show the class of subjects well and ill suited for illustration by this method. It would have been interesting to have had more explanation in the book itself of the flies figured and the reasons for their selection, especially from so ardent an advocate of the wet fly as Mr. Hodgson.

Mr. Gwynn's book is most delightful; we have read much of it before in various periodicals, but nothing is lost in reading it again in book form, and the print and general get-up are so good as to give an additional pleasure to the reader. The proverb which Micky applied to the author's efforts to catch a salmon to misquote it—*Is fada do leabhar gan bradan,* cannot in any sense be applied to his efforts to write a book; it is the book that is too short, and there is a wonderful store of really useful information not only as to salmon, but as to trout and, in one excellent essay, pilchards.

Unlike Mr. Hodgson's book, Mr. Patterson's "An Angler's Year" contains a large amount of information which should be of the greatest assistance to the beginner. The method by which the author deals with his subject is good; he selects typical days from each month in the year (except March, which he not unfairly regards as "the silly season of angling"), and describes actual experiences of his own, illustrating them with information as to the best gear and method of using it in each instance. Without ever becoming didactic, Mr. Patterson gives a great deal of most useful advice upon many forms of fishing, and is equally interesting whether he treats of trout or conger. There is one addition which would, we think, be appreciated in any future edition, and that is an index, and it really seems an undue economy of space to print advertisements on the back of the title-page and table of contents; still, these are but details (as is the quaint misprint which causes the pike to figure as *Essex lucius*), and in no way affect the value of what appears to us a very practical and useful little book.

It has lately been suggested that there is nowadays too great a tendency to attribute human characteristics to animals; the fisherman certainly tends to attribute them to fish; Mr. Patterson expresses a conviction that the Test trout know more than the anglers; Mr. Hodgson combats at some length the views of those who hold that trout are cunning; both are at issue with Sir Herbert Maxwell as to a trout's sense of colour. The task of approaching the presumed feelings of a fish—especially with a view to deceive—without attributing to it some almost human qualities, even as Mr. Patterson attributes the cunning of the carp to the size of its brain and the fulness of its years, is not easy; there is a tendency almost automatically to put oneself in the place of the fish and to try to look at the world from that standpoint, and to do this one must, to some degree, give the fish human views. Our fish are certainly more interesting a little humanised, and one can feel a real sympathy for M. Guitel's goby and his efforts to find a mate which a mere bald narrative of facts would not evoke; but in reading books on fishing one cannot help wondering whether it is really the fish or only the fisherman who likes some peculiarly compounded paste or some particular tying of a favourite fly. Somehow, while feeling sure that Mr. Gwynn and Mr. Hodgson are right in insisting on the importance of the size of fly used, we yet feel some suspicion that it is the former author and not the fish he angled for that had no taste for worms.

L. W. B.

OUR BOOK SHELF.

Betrachtungen über das Wesen der Lebenserscheinungen. Ein Beitrag zum Begriff des Protoplasmas. By Prof. R. Neumeister. Pp. iv + 107. (Jena: Gustav Fischer, 1903.) Price 2 marks.

THIS is an essay—critical and constructive—on the mechanical and vitalistic interpretations of the phenomena of life. Biology has oscillated from the one position to the other since the days of Harvey. Some progress in the physico-chemical analysis of an abstracted part or process of the organism is made, and

hope rises in the biologist's breast that the secret of life is going to be discovered. Always, however, residual phenomena are detected, and there is a retreat to some form of vitalism. Prof. Neumeister gives a scholarly survey of the history, expounding the positions of Johannes Müller, Von Baer, Lotze, Du Bois-Reymond, Fechner, Wundt, Bunge, and many more. His own position, which closely resembles that of Johannes Müller, may be briefly stated as follows:—Truly vital phenomena cannot be interpreted in terms of physico-chemical categories; life is an inter-relation of the physical and the psychical—an inseparable, unknowable inter-relation; there are no forces operative in protoplasm which are not operative in non-living matter, but in all active protoplasm there are psychical qualities of a transcendental character.

Biologists will probably be most interested in the section of the book that deals with protoplasm, and the many conceptions of it that have been suggested, *e.g.* by Nägeli, Kühne, Bütschli, Pflüger, Pfeffer, Verworn, Hofmeister, Hertwig, and Ostwald. Neumeister deals at especial length with the Hofmeister-Ostwald theory, which practically reduces metabolism to a series of fermentations. As a chemical physiologist the author attacks this theory with might and main, and comes to the conclusion that ferments have really nothing to do with the essential activity of protoplasm, their activity is intracellular, not intraprotoplasmic, they are only the "chemical tools" made by and used by protoplasm. What then is protoplasm? A peculiar chemical system of very diverse protein-substances, along with certain other compounds the molecules of which by a unique interaction give rise to psychical and material processes quite inseparable from one another, in a way that we cannot hope to understand. "Ins Innere der Natur dringt kein erschaffener Geist."

J. A. T.

The Fat of the Land. The Story of an American Farm. By J. W. Streeter. Pp. xi+406. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1904.) Price 6*s.* 6*d.* net.

MANY ways have been adopted of teaching agriculture, but we do not think we have before met with an account of the management of a farm thrown into the form of a tale—a romance some readers would be unkind enough to call it. The book describes how an American doctor, warned for reasons of health to abandon a city life, purchased a neglected farm and by a liberal exercise of capital, energy and business capacity, made it both pay its way and provide him at the same time with health and pleasure, so that the family all lived on "the fat of the land." The main text is sound enough, that the farm should be regarded as a factory converting raw material into finished products and that skill and knowledge can always find a satisfactory market by the production of the best, but we doubt if the demonstration will prove convincing or even suggestive to the practical man.

The book reminds us irresistibly of the "Swiss Family Robinson," and bears about the same relation to agriculture as that friend of our childhood did to serious natural history.

Die Dissozüerung und Umwandlung chemischer Atome. By Dr. Johannes Stark. Pp. vii+57. (Braunschweig: F. Vieweg und Sohn, 1903.) Price 1.50 marks.

THIS little book from the fluent pen of Dr. Stark, of Göttingen, is a reprint of three articles in the *Naturwissenschaftliche Rundschau.* Its object is to exhibit a comprehensive view of the application of the electron theory to the group of phenomena which may be characterised as subatomic transformations, and to do this in terms which may be understood by any person of intelligence. On the whole this object is successfully accomplished.

The author shows how the discovery of Röntgen rays and of the Zeeman effect, together with the determination of the mass of the particles forming the kathode rays, have led, in the hands of J. J. Thomson, to an entire change in our ideas of atomic structure. He follows out the bearing of this idea on the phenomena of conduction in metals, in solutions and in gases, and shows how the brilliant researches of Rutherford and of Rutherford and Soddy on radioactivity led them to consider that this phenomenon was caused by the transformation of one element into others, a result which was finally established by the discovery of Ramsay and Soddy that the radium emanation turned into helium.

The book is clearly written, and its value is increased by a chapter of references at the end. It may confidently be recommended to all interested in the recent developments of physical theory.

O. W. R.

Nature's Story of the Year. By Charles A. Witchell. Pp. xii+276; illustrated. (London: T. Fisher Unwin, 1904.) Price 5*s.*

"OBSERVERS of Nature," says Mr. Witchell in his preface, "belong to one of two classes—the scientific and the imaginative." Mr. Witchell himself belongs to the latter category, for, to make use of his own words, he depicts "some curious incidents in Nature in a frame of imaginative colouring." The book will probably give readers a general interest in natural phenomena, for there is no attempt systematically to describe the plant and animal life to be found in the country at different seasons of the year. The author directs attention to anything that happens to have impressed him, and his facts and fancies are expressed in pretty terms.

Essays and Addresses. By the late John Young, M.D., Regius Professor of Natural History in the University of Glasgow. With a Memoir. Pp. xlii+145. (Glasgow: James Maclehose and Sons, 1904.)

THIS small collection of essays and addresses is issued by the committee in charge of the memorials of the late Prof. Young. The biographical sketch with which the volume commences is by Dr. Yellowlees, and it is a pleasing narrative of a well-filled life. The history of the years when Young was on the Geological Survey is particularly attractive, though throughout the narrative the reader is impressed with Young's untiring energy. The committee has selected the following essays and addresses for publication:—"Three English Medical MSS.," "A Discourse," "The Making of a Book," "The Scientific Premonitions of the Ancients," "Jewish Mediciners," and the "Address on the Hunterian Library."

The Globe Geography Readers. Senior. Our World-wide Empire. By Vincent T. Murché. Pp. 392. (London: Macmillan and Co., Ltd., 1904.) Price 2*s.* 6*d.*

THE latest of Mr. Murché's books is one of his best. It provides a simple, interesting account of the countries and peoples of the British Empire which should make the boys and girls who study it interested in different parts of the world. The volume is profusely illustrated with sixteen full-page coloured plates and an unusually large number of black and white pictures There is no rigid adherence to geographical information alone; the historical facts necessary to make up a complete description of a country are included judiciously.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Disaster to Submarine A1.

AT the inquest on the victims of the disaster to submarine A1, Commander Bacon is reported to have expressed the opinion that as the result of the collision every soul on board was instantly stunned, since the failure to set in action the mechanism for bringing the boat to the surface could not otherwise be accounted for. It is surprising that this opinion should have been received and adopted without comment by both the coroner and the lay Press, seeing that such a result is contrary to all experience of collisions at sea. The occupant of the conning tower, which was the part struck, was no doubt stunned, probably killed, by the blow, but it is difficult to believe that the same fate should have befallen every other person on board, however remote from the point of concussion.

The fact that the naval authorities can suggest no other reason for the failure to rise to the surface after the collision is not in itself a sufficient justification for the acceptance of an opinion which, from the physiological point of view, is, to say the least, highly improbable, and certainly requires confirmation by experiment.

University, Edinburgh, May 1. E. A. SCHÄFER.

The Life-history of Radium.

EVIDENCE of a convincing nature is rapidly accumulating to the effect that helium may be produced as a result of the disintegration of the radium atom. On the other hand, it has been suggested by Rutherford and others that radium is analogous to the first products of the disintegration of uranium and thorium—to the substances known as uranium X and thorium X—rather than to those elements themselves. Such an idea points to a search for the parent atom, by the dissolution of which radium is formed.

In Prof. Rutherford's recent book on radio-activity, reasons are given for suspecting that in uranium itself we shall find the origin of radium. The atomic weight of uranium is greater than that of radium. Radium is discovered in minerals rich in uranium, and the amount of radium in good pitchblende is about that to be expected on the view that a balance exists between the rate of development of the radium by the uranium present and the rate at which it decays by the ordinary process of radio-activity.

My wife and I have been investigating lately the slight amounts of radium emanation that are almost invariably found in samples of salts and oxides of uranium sold as chemically pure. By the kindness of Mr. H. J. H. Fenton we have been able to examine several specimens of uranium compounds, known to have been preserved in the Cambridge University Chemical Laboratory for periods of from seventeen to twenty-five years. In all cases greater amounts of radium emanation have been obtained from these old specimens than from more recently prepared samples of the corresponding compounds.

It is, of course, possible that a limited number of such results may be accidental, and, in order that indirect evidence of this kind should possess any weight, enough specimens must be examined to enable us to deal with the subject statistically. I should be very grateful if anyone possessing uranium compounds of known pedigree, prepared thirty years ago or upwards, would either test them quantitatively for radium emanation, or send a few grammes of them to me for examination.

If, in most cases, an excess of radium is discovered in the older samples, it would be presumptive evidence in favour of the view that radium is formed by the disintegration of uranium, but the possibility of some general change in the methods of preparation of uranium salts renders even such a confirmation of doubtful validity.

The only convincing evidence would be supplied by tracing the gradual growth of radium in a mass of a compound of uranium. At first sight, it would seem that the time required for such growth would put the possibility of such a confirmation beyond the reach of one human life. But a short calculation shows that the attempt is not so hopeless as might be imagined.

The average life of a radium atom is taken by Rutherford, on a minimum estimate, as about fifteen hundred years. The process of decay occurs in a geometrical progression, and thus in one year about half a milligramme per gramme of radium should disintegrate. On a maximum estimate for the life, the fraction disintegrated per year is 1/100 milligramme. Taking this maximum estimate as the least favourable for our purpose, we see that in one year the one hundred thousandth part will break up.

If in pitchblende, radium is in radio-active equilibrium with its source of supply, the same fraction must be replaced in the year by the disintegration of uranium. In presence of a large excess of uranium, the production of radium would go on at a constant rate. Thus in one year about the one hundred thousandth part of the proportion of radium in pitchblende would be developed in an equivalent mass of uranium.

We find that, using a good electroscope, it is easy to detect with certainty the radio-activity from the radium emanation evolved on heating a milligramme of good pitchblende. In order to produce from uranium an amount of radium large enough to detect by its radio-activity in a reasonable time—let us say one year—it is merely necessary to work with a sufficient quantity of uranium to give, in that time, a mass of radium of which the emanation has an activity equal to that evolved from a milligramme of pitchblende. The requisite quantity of uranium is clearly about $0.001 \times 100000 = 100$ grammes. This, as we said, is a maximum estimate; it is probable that less would suffice.

In this manner, by putting on one side a few hundred grammes of some compound of uranium, carefully freed from radium and tested for emanation, it should be possible to detect the growth of radium in a time measured in months, or, on the other hand, to show that it is necessary to look elsewhere for the parent atom of radium.

At the present time we have such an investigation in progress, and trust that eventually we may obtain definite results. But, in the hope that others may undertake a similar task, I venture to place the principles of the method before your readers. On such a fundamental point, several independent experiments are greatly to be desired.

W. C. D. WHETHAM.

Upwater Lodge, Cambridge, April 30.

Graphic Methods in an Educational Course on Mechanics.

THOUGH no one, I venture to think, will gainsay Mr. W. Larden's main contention that "analytical methods give a grasp of the principles of statics, while graphical methods disguise them," yet it should not be forgotten that the analytical treatment has its own set of snares and pitfalls.

Mechanics is a physical science, and like other sciences should be approached from the experimental side. If the initial stages are treated experimentally, the principles underlying the subject will come prominently into view. One need only mention the principle of moments, which every boy has surely grasped, in a general sort of way, long before he has opened a text-book on statics. He has only to carry out a few simple experiments on levers to find out the law for himself in its exact form. Let the beginner hang up two spring balances from nails and then attach a weight by a couple of strings to the hooks of the balances, and he will soon discover for himself whether or not the pulls in the strings are proportional to their lengths.

The graphical treatment lays stress on the empirical and tentative side, which in the symbolical is completely lost sight of. But the superlative advantage of graphical work is its essentially practical character. All cases of a problem can be solved with equal facility. Ladders are not as a rule inclined to the ground at an angle of 60°, coefficients of friction are never quadratic surds, and weights of $\sqrt{2}$ poundals belong to some other world which is not the one in which we live. Again, the question is on a screw jack, and a boy taking $\pi = 22/7$ has worked out an answer

to four or five significant figures, and in consequence expects to get greater credit than his more indolent neighbour who has been content with two or three significant figures. Instances might be multiplied; they constitute the daily purgatory of every teacher. Something surely is to be said for a method which avoids these absurdities.

Analytical methods have so dominated the elementary text-book that many boys have the idea that statics is practically useless. They have no notion, for instance, that graphic statics lies at the foundation of bridge construction. Besides, in how many questions in the elementary text-book is the principle involved wholly obscured, because a trigonometrical conundrum is required and not an application of the conditions of equilibrium to give the unknown forces? In a popular text-book one-third of the questions at the end of one of the chapters are of this character. Is it to be wondered at that the average boy gets the idea that mechanics is a subtle epilogue to trigonometry?

Each question treated graphically should be regarded in the light of an experiment, in which the student should get the best result available with the means at his disposal. In any actual problem the *data* themselves are not correctly known, and the *quaesita* are therefore subject to all sorts of cumulative errors. This he quickly finds out by comparing his result with that of his neighbour, and he readily gets a notion of the degree of accuracy that he himself with pencil and ruler is capable of.

Mr. Larden writes:—"a student well trained in analytical methods can always pick up graphical methods rapidly when he needs them for special work." But will he do so? The engineer is not trained in analysis and allowed to adopt a graphical method when a specific problem arises. My experience is that the student, who has mastered analytical methods, is apt to consider graphical work as drudgery, and when called upon to solve a question graphically does not treat it with sufficient respect, and gets an indifferent result. A certain amount of finesse and judgment in choice of scale and of position of the initial force or load is required "to fit the diagram on to a given sheet of paper." This can be acquired only by practice.

Unfortunately it is too true that "graphical work consumes an amount of time that seems out of proportion to the mental training and knowledge of principles gained," but only when applied to too many similar questions. This, however, is misusing, not using the method.

I believe the best results will be obtained when the two methods are used side by side. They are strictly complementary, and the merits of each supply the deficiencies of the other. R. M. Milne.

R.M. Academy, Woolwich.

Asser and the Solar Eclipse of October 29, 878.

Under the date DCCCLXXIX, Asser, in his "Life of King Alfred," gives the following entry:—"*Eodem anno eclipsis solis inter nonam et vesperam, sed proprius ad nonam, facta est.*" The oldest manuscript of the Anglo-Saxon Chronicle also notes an eclipse in 879, but it cannot be doubted that in each case the reference is to the eclipse of October 29, 878, which was total in South Wales and southern England. Particulars of the eclipse are given by Mr. Maguire in the *Notices* of the Astronomical Society, vols. xlv., 400, and xlvi., 26. The sun rose totally eclipsed in 73° N. and 42° 8′ W. at about 9.53 local time, and the central line of the eclipse, after passing near Dublin, Aberystwith, Dover and Fulda, went off the earth at sunset about 130 miles south of Moscow at 4.20 local time; St. David's, Winchester and London were within the limits of totality. With regard to the hour of the eclipse, it is needful to consider not only mean time and apparent time, but also natural time, which was the kind of time then in use, according to which the period between sunrise and sunset was conceived to be divided into twelve hours, which were, of course, much shorter in winter than in summer. As the sun rose at London on the day of the eclipse about 7.20, the natural hour would have contained only about 47 minutes of mean time. Mr. Maguire gives the middle of the eclipse at St. David's about 1.12, and at London about 1.18 mean time, and subtracting the equation of time, about 15 minutes, we have 12.57 and 1.3 for the apparent time as shown by a sundial; correcting for natural time, we obtain 1.13 for St. David's and 1.20 for London. Finally, making allowance for the difference of longitude, we see that totality occurred at St. David's at 12.46, and at London at 1.20, according to local time as shown by a waterclock, or some other time-keeper, properly regulated to mark the natural hours. We now have to consider what Asser meant by *Nonam* and *Vesperam*. Those who have written about the passage have taken *Nonam* to be identical with *Nonam Horam*, but probably they have not been right in doing so. It is shown in the "Dictionary of Christian Antiquities" (i. 793) that the day and night were divided into four equal parts, and that each quarter of the day was named after the last hour in it. "None embraces the seventh, eighth and ninth hours; and the last called Duodecima contains the tenth, eleventh and twelfth, ending at Sunset." Asser, however, evidently uses *Vespera* for *Duodecima*. *Nona* is, in fact, noon, the point when the sun is on the meridian, the beginning of the seventh hour, and *Vespera* is the point half-way between noon and sunset, in this case 2.20 mean time and 3.0 natural time. Thus what Asser says is this, that the eclipse was total at a point of time between noon and 1.30 natural time, and we see that the statement is true for any point in England or Wales. If we could be sure that the sentence about the hour of the eclipse was written by Asser of St. David's, it would be a very strong argument, indeed, for the genuineness of the book which is called by his name, for it fixes the moment of the eclipse correctly to within seventy minutes of mean time for any place at which it is possible that the book could have been written. C. S. Taylor.

Banwell Vicarage, April 23.

"Abdominal Ribs" in Lacertilia.

It is usually stated in text-books that among living reptiles only the Crocodilia and Hatteria are furnished with abdominal ribs or parasternum: that is, of course, in the condition of thin pieces of bone lying between the ventral muscles and underlying the true ribs, for no one doubts that the plastron of the Chelonia is the same structure exaggerated. There has been some little confusion between the abdominal ribs and the ventral moieties of the true ribs in Lacertilia, which is cleared up by Dr. Gadow in his contribution to the "Cambridge Natural History." Dr. Gadow correctly observes of the geckos that they possess very long and slender post-thoracic ribs, "which meet each other in the middle line, in this case bearing an extraordinary resemblance to the so-called 'abdominal ribs' of other Reptiles." The statements as to "abdominal ribs" made by M. Boulenger in his catalogue of the lizards in the British Museum appear to me to refer to true ribs. Of the Scincidæ, he remarks that "ossified abdominal ribs are absent." Curiously enough, it is precisely in this group that I find a parasternum. In *Tiliqua scincoides* the ventral musculature is divided by the usual tendinous septa into successive "myotomes," the tendinous intervals being distinctly ossified; there are several pairs of these bonelets which seem to be exactly like those of Hatteria, with which I have compared them. That they are not the ventral moieties of the true ribs is shown by the fact that they overlap the latter, the two series of structures lying at a different plane in the musculature. I intend to make a more detailed communication to the Zoological Society upon this subject immediately. Frank E. Beddard.

Inheritance of Acquired Characters.

Regarding the "non-inheritance of acquired characters," the following is interesting:—

I was recently visiting a sugar plantation near Ottawa, Natal, and there was shown four fox terrier pups about a fortnight or three weeks old, two of which had been born with quite short tails, and one with a tail shorter than the normal. The fourth pup had a full-length tail. The mother was an ordinary fox terrier with cut tail. When the circumstance of these dogs being born with short tails was first mentioned to me I refused to believe it; but examination showed that the short tails were really naturally short tails and not tails that had been cut, that is to say, the short tails had at their ends the usual tapering vertebræ of a normal dog's tail, and, of course, at this age it was easy to see that the tails had not been cut or bitten off.

Cape Town, April 7. D. E. Hutchins.

THE POPULARISATION OF ETHNOLOGICAL MUSEUMS.

SPEAKING broadly, museums may be divided into two main classes, (1) those that are designed to interest and instruct the general public, and (2) those that are intended for specialists. Difficulties and misunderstandings arise when these two objects are not kept apart. The casual visitor is impressed, but scarcely edified, by long series of named specimens, and the specialist does not need popular descriptive labels, but he does require a large number of specimens. The problem that is now before most of our large museums is the conflict of these two interests. Probably the most satisfactory solution will be found in keeping these two classes of collections quite apart. Dr. F. A. Bather, in his suggestive and practical presidential address to the Museums Association (*Museums Journal*, vol. iii., 1903, pp. 71, 110), said, "the functions of museums are three: Investigation, Instruction and Inspiration appealing respectively to the Specialist, the Student, and the Man in the Street. These functions are so distinct that they are best carried out if museums, or the collections of a single museum, be classified on these lines. Such an arrangement is a saving of trouble and expense, and each division can thus be directly adapted to the class of visitors for which it is intended."

The specialist needs all the specimens he can get in a building where they can be safely housed and be readily accessible; he asks for facilities, not for architecture. If once this were fully realised a considerable amount of unnecessary expenditure could be saved. There are many objects that should be preserved for future generations which are neglected by museum curators because they cannot afford to store them, but there would be less excuse for this neglect if the cost of storage could be greatly reduced. At the Liverpool meeting of the British Association Prof. Flinders Petrie advocated the erection of a repository for preserving anthropological or other objects; an outline of his scheme was published in the *Report*, 1896, p. 935, and to the present writer it appears that something of the kind will have to be adopted by most countries, and the sooner this is done the better will it be for science, as objects that should be preserved are continually perishing or are discarded from lack of space in which to house them.

The general public provides most of the funds for the establishment and maintenance of museums, and it may very well insist on having something for its money that it can understand. A museum can be made into an institution of very great educational value without loss of attractiveness if some trouble be taken and if funds are available, and it is very probable that funds would be available if the results were such as could be appreciated by everyone. Our Natural History Museum at South Kensington has set a fine example of what can be accomplished in the way of well mounted birds in their natural surroundings. Probably lack of space and funds has prevented the authorities of the Natural History Museum from constructing large groups of mammals similar to those which form such a splendid feature of the Field Columbian Museum of Chicago, and to a less degree of the American Museum of Natural History, New York.

The pleasure and instruction afforded by the realistic mounting of groups of animals are undoubtedly very great, and not less so are those caused by analogous ethnological groups. The present writer had his first interest in ethnology awakened by the excellent modelled groups of natives in the Crystal Palace, and the wonder and delight these gave to the small boy have never been forgotten. Various museums at home and abroad possess individual figures dressed in appropriate costumes, but it is again to the United States that we have to turn for the most effective development of this art. There are several first class groups of American natives in the American Museum of Natural History, others are to be found in the Field Columbian Museum; especially noteworthy in the latter museum are the groups illustrating the

FIG. 1.—A Cocopa Indian family of the Sonoran ethnic province, Lower Colorado River, Mexico. They subsist largely by means of agriculture, feeding partly on game and fish, with various seeds, roots and fruits. They dwell in scattered settlements. The men wear skins and the women petticoats made of the inner bark of the willow.

rituals of the Hopi Pueblo Indians, to which the attention of the readers of NATURE was directed a short time ago (NATURE, vol. lxvii., p. 392), and a wonderful case illustrating the domestic industries of the Hopi. It was once the writer's good fortune to be in the company of a couple of Navaho Indians who saw these models for the first time; they could not mask the interest they felt in seeing these representations of their neighbours, and great was their delight in noticing that the model of a particular woman, whose face they recognised, had, like her original, an amputated finger.

The high-water mark at present reached in this direction is in the dozen groups of lay figures designed by Prof. W. H. Holmes, and first exhibited in the Pan-American Exposition in Buffalo, 1901, to which reference has been made in these pages, and which are now in the National Museum at Washington. These groups present in the most striking manner possible a synopsis of the American aborigines, from the

Eskimo of North Greenland to the wild tribes of Tierra del Fuego. Each lay figure group comprises from four to seven individuals, selected to convey best an idea of the various members of a typical family. The activities of the people are illustrated, and the various products of industry are, so far as possible, brought together in consistent relations with the group. No one who has seen these splendid groups can doubt that this is the best way of illustrating the more salient features of ethnology, especially when these are supplemented, as in Prof. Holmes's scheme, with models made to scale of habitations and of boats, with a limited selection of objects made by the various people, and illustrations of their more important physical characters, such as crania, casts from life, and pictures. An exhibit such as this for all the more important groups of mankind would be of extreme interest and educational value, and would meet all the requirements of the public. If this arrangement were carried out the great bulk of ethnological material, which takes up so much space in large museums, need not be exhibited to the casual visitor.

There are two methods of constructing the lay figures of ethnological groups. The one is to make casts of actual individuals, and the other is to have effigies made by a sculptor. The Chicago groups are examples of the former method, but the Washington groups were made in the following manner:—"The sculptors were required to reproduce the physical type in each instance as accurately as the available drawing and photographs would permit. Especial effort was made to give a correct impression of the group as a whole, rather than to present portraits of individuals, which can be better presented in other ways. Life masks, as ordinarily taken, convey no clear notion of the people; the mask serves chiefly to misrepresent the native countenance and disposition; besides, the individual face is not necessarily a good type of a group. Good types may, however, be worked out by the skilful artist and sculptor, who alone can adequately present these little-understood people as they really are and with reasonable unity in pose and expression."

FIG. 2.—A dwelling group of the Pawnee Indians, a type of the Missouri Valley region. The Pawnee formerly lived in Nebraska. Although their home is in the country of the skin-tent dwellers, they continue to build the ancient northern type of earth-covered aboue with slightly sunken floor.

These groups and the other ethnological exhibits prepared under the direction of Prof. Holmes are figured and described in the annual report of the U.S. National Museum for 1901, published by the Smithsonian Institution in 1903. In the same volume will be found Prof. Holmes's views on the classification and arrangement of the exhibits of an anthropological museum. This essay, which will prove of considerable value to those concerned in this class of work, was previously published in the *Journal of the Anthropological Institute* (vol. xxxii. p. 353).

In his address Dr. Bather dealt mainly with art museums, but he alluded to folk museums, and Mr. Henry Balfour, in his recent presidential address to the Anthropological Institute, advocates the establishment of a national museum to illustrate the evolution of culture in our islands; he, like Dr. Bather, instances what is done in this respect in Scandinavia and Germany. Certainly this is much needed in our country, and immediate steps should be taken to realise it; already much has irrevocably been lost, as there was no institution that cared to preserve the relics of former conditions. In the same address Mr. Balfour gives some valuable suggestions for the arrangement of ethnological museums. Mr. Balfour's address will be printed in the forthcoming number of the *Journal of the Anthropological Institute*, and it will be found to be well worth perusal, as it embodies the long experience of a well-known expert in museum arrangement. It is to be hoped that the time may not be far distant when the educational value of properly arranged ethnological museums will be recognised in this country, and the means will be found to establish them.

A. C. HADDON.

ROUND KANCHENJUNGA.[1]

THIS work of Mr. Freshfield's on a tour round Kanchenjunga comes as a very welcome addition to the literature that deals with the great mountain peaks of the world. Kanchenjunga (28,150 feet) is the third highest measured peak on the earth's surface, Mount Everest being 29,002 feet, and K^2, in the Karakoram range north of Kashmir, 28,278 feet high. At present Mount Everest is hopelessly impossible of access, being in Nepal, a country entirely closed to Europeans; K^2 also lies so far removed from civilisation that it takes weeks of travelling, many days of it over glaciers, to arrive even at its base.

Kanchenjunga, however, can be seen from Darjeeling, and the view of the peak from that place is one of the grandest sights in the world. Kanchenjunga and its attendant peaks form a solitary group of mountains, which divides the province of Sikkim from eastern Nepal, and lies far south of the watershed of the Himalaya.

It is now many years since Sir Joseph Hooker in 1848–1850 made his famous journeys into the country round Kanchenjunga, and obtained leave from the Government of Nepal to travel in the Nepalese valleys on the west and south-west of Kanchenjunga. This leave has never been repeated, and it was not until Mr. Freshfield and his party descended the glaciers on the north of Kanchenjunga and trespassed in the Kanchen valley that Englishmen again set foot in this forbidden land.

[1] "Round Kanchenjunga; a Narrative of Mountain Travel and Exploration." By Douglas W. Freshfield. With Illustrations and Maps. (London: Edward Arnold, 1903.)

Briefly summarised, Mr. Freshfield's tour was as follows:—Starting from Darjeeling he made his way up the valley of the Teesta River, which, running southward, bounds the whole of the Kanchenjunga range on its eastern side; leaving this valley the Zemu River was followed until the Zemu glacier was reached. Here it was that the party were overtaken by the great storm of September, 1899, which "after devastating Darjeeling, swept across Kanchenjunga into Tibet in the form of a premature snowfall, lowering the snow-level nearly 4000 feet and practically closing the highest region." As there was no wind the snow did not drift, but after the storm was over it lay between three and four feet deep round the tents.

Such conditions would have turned back most travellers and stopped any attempts to cross passes more than 20,000 feet high. Mr. Freshfield, however, was not discouraged, and although even a partial ascent of Kanchenjunga was out of the question, still he managed to lead the party over the northern ridge of the Kanchenjunga range and to explore some totally new ground in eastern Nepal. Before doing this he moved north-eastwards to Lhonak. It was from here that the party, together with the baggage train of coolies, crossed over the Jonsong La (20,207 feet). On the west side of this pass lay Nepal, an unknown land. For several days the route lay downwards over glaciers, and it was only after nearly a week spent on the ice and snow that the party finally arrived at the upper grazing grounds of the cattle belonging to the Nepalese village of Kangbachen. Here it was that they connected their route with that of Sir Joseph Hooker, who fifty years previously had visited this valley.

As the party were now in forbidden country, some anxiety was felt as to their reception by the inhabitants, but with the exception of one official no trouble was met with, and as an excuse for the trespass it was pointed out that, driven by the great snowstorm over the pass, the party were seeking their way back to British territory, and that obviously their nearest way was down the Kanchen valley, thence by the Chunjerma and Kang La back to Darjeeling.

From many points of view this work of Mr. Freshfield's is of interest; it is a delightful record of mountain exploration, it is splendidly illustrated, and the descriptions of ice-clad mountains, of tropical forests, and of the great beauty of the atmospheric effects in this great mountain range are all given most admirably by the author. Moreover, many most interesting scientific and geographical problems are discussed.

Fig. 1.—Camp below the Jonsong La. From "Round Kanchenjunga," by Mr. Douglas W. Freshfield.

One important question was as to whether there are peaks higher than Mount Everest lying further to the north in Tibet. Twenty years ago Mr. Graham, from the summit ridge of Kabru, at a height of more than 20,000 feet, asserted that he saw two peaks, one covered with snow and one of rock, further north than Mount Everest, and that they appeared as high, possibly higher, than Mount Everest. This statement has been partly confirmed by native explorers. That high peaks exist there is undoubted, and one was seen from the Chunjerma Pass by Mr. Freshfield. Also more recently a photograph taken by Mr. H. H. Hayden, and published in the *Geographical Journal* (1904, 362), shows these peaks. Mr. Freshfield, commenting on this photograph, says:—"Somewhat to the north-west of Chomokankar (Mt. Everest) appears a great group of peaks; one rock and one snowy

summit are conspicuous. These are apparently as yet unidentified and unmeasured. They rise at no great distance beyond Chomokankar, and are probably south of the Tingri Maidan."

During late years much has been written about the effect of rarefied air at high altitudes on the human system. Mr. Freshfield and his party suffered but little inconvenience, even when on the summit of the Jonsong La (20,207 feet). That the effects of low barometric pressure have been much exaggerated is also borne out by the experience of Mr. White, political officer in Sikkim, who says:—"I find that the height is felt most at from 14,000 to 16,000 feet, and that if they (the coolies) once get over that, going to a still higher altitude has very little further effect. Personally the height does not affect me, and I felt perfectly well at 21,200 feet."

The geology of the district is most ably described by Prof. Garwood, by whom also an excellent map of the whole Kanchenjunga range has been made.

Mrs. Le Mesurier has contributed a chapter on Tibetan curios, and in the appendix, besides the exhaustive description by Prof. Garwood of the geological structure and physical features of Sikkim, there is a mass of important and interesting matter collected by the author; on the narratives of journeys made by native surveyors; on the various native names for the highest measured peak (Mount Everest); also a most useful list of books and maps consulted, and last, but not least, a list of photographs taken by Signor V. Sella during the tour of Kanchenjunga.

"Round Kanchenjunga" is a book worth reading from many points of view; it is not merely a tale of mountaineering adventure, but is full of information, artistic description, and new facts. It is a book which undoubtedly will be "serviceable to Alpine climbers and men of science, and not without interest for those who 'love the glories of the world' and count among them great mountains."

HIGHER EDUCATION IN THE UNITED STATES.[1]

ALL intelligent attempts to make known in this country the extent and success of American educational enterprise deserve encouragement. So well considered an effort as that of Mr. Mosely not only merited but has received enthusiastic appreciation. By securing the assistance of educationists representative of successive steps in a complete educational system, Mr. Mosely has been able to bring together in convenient compass authoritative expressions of opinion as to the precise state of each grade of education in the United States, and to provide our new educational authorities with information as to the characteristics of American education which good judges think might with advantage be copied in this country. Similarly, the features of the work of schools and colleges in the States which should be discouraged among us are in this report duly indicated. Mr. Mosely has, too, made arrangements to ensure a wide circulation for the valuable material collected under his auspices. By forwarding to the publishers of the volume the cost of postage and stating his qualifications, any member of an educational authority, any county councillor, local manager, headmaster, or registered teacher may obtain a copy of the book free.

The twenty-six separate reports contained in the volume cover the whole field of education from the kindergarten to post-graduate university study, but it will be possible in this place to refer to a few only of the more important directions in which American practice offers British educationists food for serious reflection. The most prominent place may well be given to an impression received by all the commissioners alike, and recorded first in their joint report; we refer to "the absolute belief in the value of education both to the community at large and to agriculture, commerce, manufactures, and the service of the State" which distinguishes the inhabitants of all the United States. Side by side with this record of their observations must be placed the commissioners' message to their countrymen, which is expressed as a desire "to impress on the British public the absolute need of immediate preparation on our part to meet such competition" as this enthusiasm for education in America will lead us to experience. Evidence of the advances in American education, and also of the sacrifices made in the States to endow and develop colleges and universities, have been frequently laid before readers of NATURE But though here and there in Great Britain a desire has been manifested to found new universities, and though we are glad to admit that a few of our men of wealth have emulated the example common among American millionaires of giving largely to educational institutions, a general awakening on the part of the nation so far as a thorough belief in education is concerned is still a matter of the future. Meanwhile, the schools and colleges of the United States go steadily on with their work of preparing the rising generation. As Mr. W. P. Groser, who was nominated to the commission by the Parliamentary Industry Committee, says in his report, "England is now competing with American commerce in the making. In the next generation our manufacturers will meet trained men, adding culture to their enterprise and knowledge to their ambition."

Another striking difference between the English and American attitude towards education is appreciated by comparing the relations in the two countries between industry and higher scientific and technical instruction. The report makes it abundantly clear that in America there is complete sympathy between the manufacturers and the college professors, and that properly trained college men are in great demand. Says Prof. Ayrton, "I saw that there actually existed that close bond of union between the industry and the teaching which only the more sanguine of us have hoped they might, perhaps, live to see introduced into our own country." Mr. Blair asserts, "the relationship between the schools and the industries has become one of supply and demand." Prof. Ripper states, "We were frequently told that 'the American manufacturer twenty years ago, like the English of to-day, thought little of the technically trained men. The difference between us now is that the American has changed his opinion, while England appears to be where she was'" Commissioner after commissioner gives instances of the large proportion of men educated at college who are engaged in great manufacturing concerns in the States. Out of 10,000 employees in the Westinghouse shops and offices, there are 160 college-trained men employed. At the Carnegie Steel Works, where there are 7000 hands, about a hundred technically trained men are engaged, seven of the twenty-three leading officers being college graduates, and similar cases might be multiplied indefinitely.

The same enlightened policy is adopted in the matter of apprentices. Prof. Ayrton was told everywhere, "an engineering apprentice in a factory should be a college trained man," and the foreman of the apprentices at the Westinghouse works informed him, "the engineering apprentices, of whom we have about 150,

[1] "Reports of the Mosely Educational Commission to the United States of America, October–December, 1903." Pp. xxiv+400. (London: Co-operative Printing Society, Ltd., 1904.) Price 1s., post free 1s. 4d.

must be first-class graduates of leading technical schools. We start them on trial at 8*d*. an hour, and if really bright they may be earning 30*l*. a month with us at the end of eight months. We are always on the look-out for bright men; we cooperate with the professors of colleges to get them." "Two of the chiefs of the staff of the Westinghouse Company," says Prof. Ayrton later, "visit all the principal universities, colleges, and technical schools throughout the United States every year for the purpose of seeing the students, and choosing those who are most suitable to work with the Westinghouse Company." College students, too, are encouraged to work in the shops during vacation time, and in this way to supplement theoretical knowledge with practical experience.

Still another way in which the connection between the training given in the technical schools and colleges and the needs of industry is in America made intimate and real is to be found in the conditions of tenure pertaining to professorships. All the practical men engaged in engineering consulted by Prof. Ayrton were unanimous in telling him that "an engineering professor in a college should be actively engaged in the practice of his profession." Or, as he says later in his report, "engineering education in America is directed by those who are doing the engineering work of their country." Prof. Maclean's evidence is in the same direction; he states, "superior men are induced to accept collegiate appointments because of the well-equipped laboratories at their disposal, and because as engineering professors they are given every opportunity and encouragement to do outside work. It is believed that thus they keep in touch with the various lines of progress in their profession." Prof. Ripper, too, adds his testimony to the same effect. He writes, "it is considered vital that the professor should be in the field of practice, otherwise he is liable to become stale and out of date, and to attach exaggerated importance to unnecessary things."

The scepticism of the British manufacturer as to the value of a scientific training in the workshop and factory, his neglect of the technical expert, and his ingrained conservatism are already painfully familiar to men of science. It is unnecessary to insist, in view of what this latest report tells of American enlightenment, that in the absence of an earnest endeavour by British directors of industry to follow the lead of their contemporaries in the States, the results will be disastrous—indeed, fatal—to our commercial supremacy.

To turn now to the extent that science is in America utilised in the service of the State—a matter the importance of which has been urged consistently in these pages. A joint report, signed by the commissioners as a body, places it on record that "the closest connection is being established between theory and practice, the practical bent of the men of letters and science and the breadth of their outlook being very remarkable. The services of experts in various branches of knowledge are, therefore, held in high esteem and are in constant demand." And Prof. Armstrong, in a report brimful of good things, gives numerous examples of the appreciation by the American Government of the services of men of science. To quote one or two of his *obiter dicta*:—"So far as I am aware, there is nothing anywhere to compare with the way in which science is being utilised in the service of the State by the U.S. Department of Agriculture." "There is no question that the research work done under the auspices of the Agricultural Department and in the experiment stations is of the very greatest value, and is contributing most materially to the development of agricultural industry." "One branch of work initiated in the Office of Experiment Stations at Washington of extreme importance, to which reference should also be made, is that relating to the nutrition of man, which has been carried out in various parts of the States under the supervision of my friend Prof. Atwater." If it were necessary, similar examples from these reports could be multiplied a hundredfold.

In a short review it is possible only to touch the fringe of so great a subject. Much of value in the reports has been left completely on one side. But it is greatly to be desired that every man of science, every person engaged in education, whether as administrator or teacher, will study the volume. It is an important and absorbingly interesting contribution to a subject that deserves the immediate attention of every one of our statesmen.

A. T. S.

NOTES.

The annual conversazione of the Royal Society will be held on Friday, May 13.

We regret to see the announcement of the death of Prof. E. Duclaux, director of the Pasteur Institute, at sixty-three years of age.

Prof. A. W. Williamson, F.R.S., is lying dangerously ill at his residence at Haslemere.

Invitations have been issued by the Royal Society of Edinburgh to a conversazione to be held in the rooms of the society on Saturday, May 28.

Prof. Henri Becquerel, of Paris, has been elected a corresponding member of the Berlin Academy of Sciences.

The deaths are announced of Prof. Leidie (chemistry), of Paris, and Prof. Charles Soret (experimental physics), of Geneva.

In the *Physikalische Zeitschrift* for April 15, Prof. Th. Indrikson states that he has repeated Sir William Ramsay's experiments showing the spectrum of helium in the emanations from radium, the experiments being in this case conducted in the physical institute at St. Petersburg, where no experiments with helium had previously been made.

It is announced that an annual subsidy of 35,000 kr. (1950*l*.) for twenty years has been granted by the Icelandic Government for the establishment of a wireless telegraphic connection between Iceland and the Shetland Islands or the mainland of the United Kingdom, and also between the four principal towns of Iceland.

The council of the Institution of Civil Engineers has made the following awards for papers read and discussed before the institution during the past session: A Telford gold medal to Major Sir Robert Hanbury Brown, K.C.M.G., a George Stephenson gold medal to Mr. G. H. Stephens, C.M.G., and a Watt gold medal to Mr. Alphonse Steiger. Telford premiums to Mr. E. W. de Rusett, Dr. Hugh Robert Mill, Mr. Alexander Millar, and Dr. T. E. Stanton. A Manby premium to Prof. J. Campbell Brown, and a Crampton prize to Mr. L. H. Savile. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

The Geologists' Association has arranged an excursion to Derbyshire for Whitsuntide. Four days are to be devoted to out-door geology. The party leaves St. Pancras for Buxton on Friday, May 20, and is expected to arrive in London from Derby on Wednesday, May 25. On Saturday, May 21, the excursion will be directed by Messrs. H. A.

Bemrose, E. Sandeman, and H. Lapworth, but for the other three days Mr. Bemrose alone will be the director. The details of the excursion seem to have been carefully planned, and full particulars of these, together with information as to special fares and hotel arrangements, can be obtained from the excursion secretary, Mr. H. Kidner, 8 Derby Road, Watford.

A circular on the present state of the trade in indigo between India and Aleppo, prepared by the reporter on economic products to the Government of India, is noted in the *Journal* of the Society of Arts. It appears that between 600 and 700 chests of indigo are imported into Aleppo from India every year. On account, however, of the competition of German synthetic indigo, this is usually sold by the merchants at a loss. This synthetic indigo has two advantages over the natural product, viz. that it is cheaper and that its price does not vary. The native dyers have found that when natural and synthetic indigo are mixed in about equal proportions, the resulting mixture is more durable and also brighter in colour than the natural indigo. On account of the impetus that has been given to the dyeing industry by the popularity of this mixed dye, much more indigo is used than formerly, and the reduction in the demand for natural indigo has not been nearly so great as might have been expected from the introduction of synthetic indigo.

We have received a copy of the results of the magnetical and meteorological observations made at the Royal Alfred Observatory, Mauritius, in the year 1900, and we note a marked improvement in the form in which the results are now presented, being on the pattern of the Greenwich observations. The routine work has been carried out in a very satisfactory and thorough manner. Photographs of the sun are taken daily, when possible, and the negatives sent to the Solar Physics Committee in London. Meteorological bulletins are supplied daily to the local Press, and copies of monthly results are forwarded to this country and elsewhere. Rainfall observations are now made at about seventy stations, and the results are duly tabulated. Special attention is also given to magnetical and seismological observations.

Mr. J. R. Sutton has contributed to the report of the South African Association for the Advancement of Science a valuable paper containing the determination of mean results from meteorological observations made at second order stations on the table land of South Africa. Observations in Cape Colony are generally made at 8h. a.m. (mean time of the colony), but at some stations other hours are used. The object of the paper is to give materials for reducing these to a common standard of reference. At the cost of a great amount of labour, the author has calculated, from the very complete observations made at Kimberley, the corrections to be applied to means for each hour for all elements in order to obtain the true mean for each month and for the year. He makes suitable reference to the work of the late Mr. Stone, who made a somewhat similar calculation from the Cape observations for 1841–6.

Dr. T. Levi Civita contributes a note to the *Atti dei Lincei* for March 20 on Kepler's equation $nt=u-e \sin u$, and the limits of convergency of the well known expansion of u in powers of e.

Some experiments by Prof. A. Stefanini and Dr. L. Magri on the influence of radium on the electric spark, communicated to the *Atti dei Lincei*, xiii. (1), 6, by Prof. Battelli, lead to the following results:—For discharges between two spheres, or between a positively charged point or sphere and negative disc, the discharge is facilitated by radium for short sparking distances and impeded for longer ones; at these distances the radium influences the positive pole. If the disc is positive and the sphere or point negative, the discharge is impeded at small sparking distances within a limited interval; in general the effect is nil. For certain sparking distances between a sphere and disc it is possible for radium to impede or facilitate discharge according to which electrode is positive.

In the April number of *Climate*, the anti-malarial campaign at Ismailia is described. Dr. Harford discusses sleeping sickness and its cause, and articles of medical interest, reviews and notes complete the contents of this useful journal.

In a pamphlet entitled "Recent Improvements in Methods for the Bacterial Treatment of Sewage" (Sanitary Publishing Co.), Mr. Dibdin describes his multiple surface bacteria beds. The basis of his thesis is that there is no need for sewage to undergo a preliminary anaërobic treatment as in the case of the septic tank process, but that aërobic action alone suffices under the proper conditions. Mr. Dibdin constructs his beds of ridged tiles or of slate débris.

In the *Bulletin* of the Johns Hopkins Hospital for February (vol. xv., No. 155), Dr. Kennon Dunham describes the effects of the Röntgen rays on lower animal life. These differed with the particular species exposed, Chilomonas and two species of Paramæcium being killed after six exposures, each of three minutes' duration on three successive days, while rotifers, Arcella and Cryptomonas were unaffected by this treatment. As regards the different rays, those having the strongest action were found to be directed from the centre of the anode plate in a line perpendicular to its face, and focused by passing through a cylinder of sheet lead. The most destructive rays were produced by a medium low tube excited by a heavy electrical discharge which had been passed across spark gaps or other resistance sufficient to produce rays of great penetrative power, such as will give a clear picture of a deeply seated bone, *e.g.* the hip, in three or four minutes. Dr. Leonard Hirshberg proves by a number of experiments that the species of anopheles mosquito (*A. punctipennis*) so abundant in and about Baltimore does not transmit malaria. There are also other excellent articles, but of purely medical interest.

Messrs. Hepburn and Waterston, in the April issue of the *Journal of Anatomy and Physiology*, continue their account of the histology of the motor-cells and accessory nerve in the spinal nerve-column of the porpoise. Another article in the same *Journal* contains the report of the second of a series of lectures by Prof. A. Robinson on the early development of the ovum and the differentiation of the placenta in various mammalian groups.

In the April number of the *Zoologist* the editor, Mr. W. L. Distant, commences a series of articles on rivers as factors in the distribution of animals, dealing in this instance with their restrictive action. Many instances are noted where rivers form the boundary to the range of species or groups of mammals, a notable case being the limitation of the area of the viscacha by the Uruguay River, although the country to the north appears in every way as well suited to the habits of that rodent as are the pampas to the south.

Three papers on vertebrates constitute the chief contents of the instalment of the *Proceedings* of the Philadelphia

Academy last to hand. In one Mr. J. A. G. Rehn continues his survey of the American bats, dealing in this instance with the genus Dermonotus (Pteronotus), a close ally of Chilonycteris, which, as already noticed in NATURE, formed the subject of his preceding article. Of the other two papers—both by Mr. H. W. Fowler—one is devoted to the description of berycoid fishes, and the second to certain fresh-water fishes from various parts of the United States.

THE presidential address to the Indiana Academy for 1902, which is only just to hand, in the *Proceedings* of that body, is devoted to a survey of the rise and progress of science in Indiana, which date practically from the conclusion of the war of secession. Special attention is devoted to the benefits conferred by science on agriculture, and it is pointed out that, as the result of these investigations, farmers in Indiana will eventually grow only such crops as are best suited to local conditions, and therefore the most remunerative.

THE second part of the first volume of *Records* of the Albany Museum contains five notes by Dr. R. Broom on South African anomodont reptiles. In one of these he discusses the affinities of the pavement-toothed genus Endothiodon, which was placed by Mr. Lydekker among the dicynodonts, but transferred by Prof. Seeley to the theriodonts. The new evidence demonstrates that the endothiodonts are so closely related to the dicynodonts that it is doubtful whether there is any cranial difference between the two groups, except the presence or absence of the palatal teeth.

AN excellent specimen of modern American zoological work is presented in a long and copiously illustrated article on the "Phylogeny of Fusus and its Allies," by Mr. A. W. Grabau, published in vol. xiv. of the *Smithsonian Miscellaneaus Collections*. The shells of gastropods, when complete, are admirably adapted for phylogenetic study, since they display the whole growth—from the protoconch onwards—externally. The characters of the protoconch are found to be of prime importance in the group in question, although these must be correlated with the structure of the adult shell. One of the most important results of this line of investigation is the discovery that the genus Cyrtulus, represented by a single species from the Pacific, instead of being inseparable from the Eocene Clavilithes, forms a perfectly distinct type. The well known shells from the Barton Eocene commonly designated in geological works *Fusus longaevus* are shown to indicate at least three specific types of Clavilithes, one of which is regarded as new, under the title of *C. solanderi*.

THE periodic growth of scales as an index of age in the various members of the cod family forms the subject of a very important paper by Mr. J. S. Thomson in the first part of vol. vii. of the *Journal* of the Marine Biological Association. It has long been known that such growths are annual in the carp, and it is therefore probable that the same holds good for salt-water fishes. So far as can be determined by observation and experiment, this induction appears to be well founded in the case of the Gadidæ, and the author is of opinion that, after making all due allowance for individual variation, the age of these fishes can be determined by the number of rings (not the smaller lines) in their scales. Labelling of individual fishes returned to the sea, after their scales have been examined, would afford definite proof of the truth (or otherwise) of the theory. The paper is illustrated with a number of excellent plates.

THE March number of the *Quarterly Journal of Microscopical Science* contains an important paper on the dermal fin-rays (dermotrichia) of fishes, by Mr. E. S. Goodrich, of the Oxford Museum. Such structures may be divided into three types. In the sharks and chimæras these rays (ceratotrichia) are unjointed and composed of a fibrous horn-like substance devoid of bone-cells, and unconnected with the placoid scales found in the skin. In Teleostomi (bony fishes and ganoids), on the other hand, we find small unjointed, horny rays (actinotrichia) on the edges of the fins, which are probably remnants of the ceratotrichia, and, in addition, branched, bony lepidotrichia, developed externally to the actinotrichia, and in primitive forms closely resembling the body-scales. They are probably derivatives from scales which once clothed the fins. Finally, the lung-fishes have jointed, bony rays (camptotrichia) containing bone-cells, and probably representing the lepidotrichia of the teleostomes. In the same issue the editor, Prof. E. Ray Lankester, re-publishes his "Encyclopædia" article on the Arthropoda, one reason for this being that it may readily come under the notice of foreign naturalists. Our readers may be reminded that the author considers the one great feature uniting chætopods, rotifers, and arthropods in a common group is the presence in each body-ring of a pair of hollow appendages—paropodia—moved by intrinsic muscles and penetrated by blood spaces.

ATTENTION was directed in NATURE (May 17, 1900) to an article by Mr. Lester F. Ward on the "Petrified Forest" of Arizona, and reference was then made to the presence of a petrified trunk which formed a "natural bridge" across a canyon. We have now received an article by Prof. Oscar C. S. Carter on "The Petrified Forests and Painted Desert

FIG. 1.—Agate bridge formed of petrified tree trunk, 111 feet long, spanning ravine in Arizona.

of Arizona" (*Journ.* Franklin Inst., April), and this contains a number of illustrations of the scenery, including the natural (agate) bridge, which we are enabled to reproduce. The silicified trunks of trees are considered to be of Triassic age, and most of them are relics of the denudation of the strata; that represented in the natural bridge is, however, *in situ*. The "Painted Desert" is so named on account of the bright colours of the sandstones, shales, and clays—the rocks being eroded into fantastic shapes, and being coloured blue, yellow, red or green in places; hence the effect in sunlight is brilliant. An illustration is given of pictographs made by cliff dwellers on a face of sandstone near the petrified forest. The silicified tree trunks mostly belong to forms allied to the Norfolk Island pine (Araucaria); other masses resemble red cedar. There are indications that the wood had commenced to decay before it was silicified. Prof. Carter believes that the petrifaction took place in the sandstone and shale, and was due to

soluble silicates derived from decomposition of the felspathic cement in the sandstone.

THE delegates of the Clarendon Press have in preparation, and will shortly publish, an authorised translation of "Das Antlitz der Erde," by Prof. Eduard Suess. This English edition of a standard work will be prepared by Dr. Hertha Sollas under the supervision of Prof. W. J. Sollas, F.R.S., and will contain a preface written for it by Prof. Suess.

THE *Electrician* Printing and Publishing Co. announce the early publication of a work by Mr. F. Soddy entitled "Radio-activity: an Elementary Treatise from the Standpoint of the Disintegration Theory." The same company will issue in a few days a book by Prof. S. Lemström, entitled "Electricity Applied to Agriculture and Horticulture."

A NEW edition of an illustrated price list of chemical apparatus has been published by Messrs. Brewster, Smith and Co., of Cross Street, Finsbury Pavement, E.C. The new catalogue contains above four hundred more illustrations than the previous issue, and also full particulars of several new devices of which we have already given descriptions.

THE eighth volume of the new half-yearly series of the *Transactions* of the Leicester Literary and Philosophical Society has reached us. It is edited by Mr. O. T. Elliot. The volume contains the presidential address of Dr. R. Pratt dealing with the subject of "over-strain" and "nervous-breakdowns," which are traced to a wrong use of leisure; four papers read before the society; and the quarterly reports of six of the sections into which the association is divided. We notice that this Leicester society was founded in 1835, and has thus had nearly seventy years of useful work.

ON account of the ease with which gold can be obtained in the pure state, the exact determination of its melting point is an important datum for high temperature measurements. Previous observers have given values ranging from 1061° (Callendar, Heycock and Neville) to 1091° (Barus), the average of the more recent work being 1064° C. In the current number of the *Comptes rendus* a new determination of this constant is described by MM. A. Jacquerod and F. L. Perrot, in which direct comparison with the gas thermometer, with fused silica bulb, is adopted. The heating was carried out in an electrical resistance furnace of special type, giving a complete control over the temperature in the neighbourhood of 1000° C. Owing to the smallness of the coefficient of expansion of silica, the correction for the expansion of the bulb amounts to only 2°, as against 35° to 40° for the same instrument with a platinum bulb. The mean result with the nitrogen thermometer was 1067°.2 C., and the results obtained when the bulb was filled with other gases showed that the coefficients of expansion of oxygen and carbon monoxide are very close to that of nitrogen.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mr. T. P. Eykyn; two Mountain Ka-Kas (*Nestor notabilis*) from New Zealand, presented by Mr. T. E. Doune; a White-tailed Ichneumon (*Herpestes albicauda*) from Africa, six White-crowned Pigeons (*Columba leucocephala*) from the West Indies, two Large-billed Weaver-birds (*Ploceus megarhynchus*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

COMET 1904 *a*.—Herr M. Ebell has calculated a new set of elements and an ephemeris for Brooks's comet, the former differing slightly from that published by Prof. Pickering. They have been derived from observations made on April 17, 20 and 24, and are given below:—

$$T = 1904 \text{ February } 28{\cdot}8792$$
$$\omega = 50^\circ\ 53'{\cdot}2$$
$$\Omega = 275\ 18{\cdot}5$$
$$i = 125\ 0{\cdot}0$$
$$\log q = 0{\cdot}42950$$

Ephemeris 0h. M.T. Berlin.

1904	α (h. m. s.)	δ (° ′)	log Δ	Brightness
May 2 ...	16 6 56	+52 44·4	0·3556	0·95
6 ...	15 50 5	+54 23·1		
10 ...	15 32 16	+55 44·8	0·3672	0·88
14 ...	15 13 50	+56 47·2		
18 ...	14 55 15	+57 31·9	0·3831	0·81

(Kiel Centralstelle *Circular*, No. 66).

It will be seen from the above ephemeris that the comet is travelling along just inside the southern border of Draco towards Ursa Major, and is becoming fainter. On May 6 it will be very near to, and south of, a small triangle of stars which is situated about 4° south of θ Draconis.

DIMINUTION OF THE INTENSITY OF THE SOLAR RADIATION.—In a communication to the Paris Academy of Sciences M. Ladislas Gorczyński publishes two tables showing, in the first, the mean monthly values of the solar intensity and the absolute humidity, and in the second the maximum values of these two quantities for each month during the years 1901, 1902 and 1903. The tables give the differences between the values for the corresponding month of each year, and show that the diminution in the intensity, which M. Dufour stated (*Comptes rendus*, vol. cxxxvi. p. 713) commenced in December, 1902, really commenced at Warsaw in May of that year. Until more positive evidence as to the effect of the dust ejected from Mont Pelée on the observed solar intensity is forthcoming, M. Gorczyński hesitates to ascribe the diminution to this cause (*Comptes rendus*, No. 5).

THE PERIODICAL APPARITION OF THE MARTIAN CANALS.—In a paper read before the American Philosophical Society Mr. Percival Lowell discusses the 375 drawings of the Martian surface made by him during the opposition of 1903. Having plotted the values allotted to the "visibility" of eighty-five canals, at different periods, with regard to the time of their minima visibilities after the Martian summer solstice, he found that these minima appeared in regular sequence from the North Pole towards the equator. Mr. Lowell believes that the canals are strips of vegetation dependent for their growth—and therefore for their visibility—upon the simultaneous presence of sunlight and water, and he points out that on a planet, such as the earth, where water is constantly present all over the surface, the appearance of vegetation solely depends upon the amount of sunlight received; therefore in the northern hemisphere it simply progresses northward with the sun. On the other hand, he concludes, from his curves, that there is no constant supply of moisture on the surface of Mars, and, therefore, although the sun may have reached the summer solstice, it is not until the snowcap melts and looses the water supply that the vegetation appears. Further, his curves indicate that when loosed the water moves southward at a remarkably steady rate of 53 miles per day, and, as the figure of the planet is shown by its spheroidity to be in a state of fluid equilibrium, he contends that the water must of necessity be conveyed southwards by artificial means.

The curves discussed are reproduced on seventeen plates which accompany the paper in No. 174, vol. xlii., of the *Proceedings* of the society.

ELEMENTS AND COMPOUNDS.[1]

I HAVE the honour of speaking to an audience of many men whom I have long venerated as my intellectual, although not my personal, teachers, and whom I admire as leaders in our common work for science. But however admirable the *present*, I am still more impressed by the thought of the *past* associated with this place. When, not long ago, I was engaged in electrochemical investigations and almost daily sought for information and enlightenment in Faraday's researches, I did not dare to think in my boldest dreams that one day I should find myself standing on the very spot in which he was wont to give the first accounts of the innumerable results of his indefatigable labours, his indomitable zeal, and his inexorable love of truth.

All that the pupil can do in such a case is to imbue himself as completely as he can with the ideas of the master and to try to perform his modest work in the master's spirit. But here arises a new difficulty: what subject ought I to choose? When I look into my own humble efforts, I find everywhere traces of Faraday. So far as relates to electrochemistry, the thing is plain; I think there is no word that I have oftener spoken or written than the word "ion," that word which was uttered for the first time in its modern sense in this very spot. But in other fields in which I have also worked, I feel the influence of his skilful hands and his keen vision. Catalysis, which I have studied during the past ten years, likewise came under his hands; and in the parts of the subject he worked at, the charm of secrecy and inexplicableness has been exchanged for the better qualities of a problem capable of resolution by earnest workers. And in one subject which has engrossed a very great part of my scientific activity, in the question of energy, I find the venerated master again a leader. He was indeed the first scientific man to direct all his investigations in view of the idea of the conservation and the mutual transformation of the various forces, as he called them, or the various kinds of energy, as we call them now.

This is a side of Faraday's mind to which, perhaps, not so much attention has been paid as it deserves. Although doubtless the greatest advance—the discovery of the quantitative proportionality between the energy which disappears and that which originates—was due to Mayer and Joule at a later date, yet the practical perception of this relation was working in Faraday's mind long before. There is indeed a great difference between the intellectual development of a scientific truth to a degree sufficient for the discoverer's *own* work, and to the degree required for its successful transfer to the minds of *other* workers. Faraday contented himself in this case, as well as in others (for example, in his conception of lines of force), with the first step. But that he had reached this step and stood firmly on it, that he used this conception constantly and regularly in his work, is evident from his constant reference to it from the first year of his scientific work onwards. From a closer study of his lectures and papers we learn that in every case he put the question: how can I change a given force into another? This continued to the very end of his work; for the last experiments he made related to the direct conversion of gravity into electricity, and although he did not succeed in his attempt, he was nevertheless convinced of the possibility of the conversion.

Guided by these considerations, I directed my attention to the very earliest problems treated by the master. Even before Faraday held the chair of chemistry here in the Royal Institution, as a youth of twenty-five years of age he practised the art of a lecturer in a small club, the City Philosophical Society, and the first course which he delivered there was on chemistry. In the sixteenth lecture, after a description of the metals, he concluded with the following general remarks:—

"To decompose the metals, then, to reform them, to change them from one to another, and to realise the once absurd notion of transmutation, are the problems now given to the chemist for solution. Let none start at the difficult task and think the means far beyond him; everything may be gained by energy and perseverance." And after a description of how in the course of history the means necessary for the isolation of the metals from their combinations have grown ever more and more efficacious, he mentioned the recent great discoveries of his master Davy as follows:—

"Lastly, glance but at the new, the extraordinary powers which the chemist of our own nation put in action so successfully for the reduction of the alkalies and the earths, and you will no longer doubt that powers still more progressive and advanced may exist and put at some favourable moment the bases of the metals in our hands."

When I try to follow this hint and take for the object of our consideration the question of the nature of the elements and of their compounds, I am aware that I am not the first who has done so in this place. If I am not mistaken, the very first chemist who had the honour of addressing you as a Faraday lecturer, Jean-Baptiste Dumas, lectured thirty-five years ago on the same subject. Nevertheless, I do not shrink from the repetition. Every generation of chemists must form its own views regarding this fundamental problem of our science. The progress of science shows itself in the way in which this is done. Faraday was at this time fully influenced by Humphry Davy's brilliant discoveries, and sought for the solution of the problem in Davy's way. For Dumas, the most important achievement of the science of his day was the systematising of organic chemistry, condensed into the concept of *homologous series*. He therefore regarded the elements as comparable with the hydrocarbon radicles, and tried to arrange them in similar series with constant differences in the numerical values of their atomic weights. It is well known that these ideas finally developed into the great generalisation we owe to Newlands, Lothar Meyer, and Mendeléeff. Although the problem of the decomposition of the elements was not solved in this way, these ideas proved to be most efficient factors in the general development of science.

From what store of ideas will a modern chemist derive the new materials for a new answer to the old question? A physicist will have a ready answer: he will construct the elements in a *mechanical* way, or, if he is of the most modern type, he will use *electricity* as timber. The chemist will look on these structures with due respect indeed, but with some reserve. Long experience has convinced chemists (or at least some of them) that every hypothesis taken from another science ultimately proves insufficient. They are adapted to express certain sides of his, the chemist's, facts, but on other not less important sides they fail, and the end is inadequacy. Learning by this experience, he makes a rule to use only chemical material for this work, and according to this rule I propose to proceed.

Hence, like Dumas, I put the question: what are the most important achievements of the chemistry of our day? I do not hesitate to answer: *chemical dynamics* or the theory of the progress of chemical reactions and the theory of chemical equilibrium. What answer can chemical dynamics give to the old question about the nature of the chemical elements?

The answer to this question sounds most remarkable; and to impress you with the importance I ascribe to this investigation, I will mention the result at once: *It is possible, to deduce from the principles of chemical dynamics all the stoichiometrical laws; the law of constant proportions, the law of multiple proportions and the law of combining weights*. You all know that up to the present time it has only been possible to deduce these laws by help of the atomic hypothesis. Chemical dynamics has, therefore, made the atomic hypothesis unnecessary for this purpose, and has put the theory of the stoichiometrical laws on more secure ground than that furnished by a mere hypothesis.

I am quite aware that in making this assertion I am stepping on somewhat volcanic ground. I may be permitted to guess that among this audience there are only very few who would not at once answer, that they are quite satisfied with the atoms as they are, and that they do not in the least want to change them for any other conception. Moreover, I know that this very country is the birthplace of the atomic hypothesis in its modern form, and that only a short time ago the celebration of the centenary of the atomic hypothesis has reminded you of the enormous advance which science has made in this field during the last hundred years. Therefore I have to make a great claim on your scientific receptivity. But still I do not hesitate one moment to lay the results of my work before you. For I feel quite sure

[1] By Prof. W. Ostwald. Faraday Lecture delivered before the Fellows of the Chemical Society in the Theatre of the Royal Institution on April 19.

that I shall find this receptivity unrestricted; and, moreover, I shall reap another advantage. For I also feel assured that you will offer me the severest criticism which I shall be able to find anywhere. If my ideas should prove worthless, they will be put on the shelf here more quickly than anywhere else, before they can do harm. If, on the contrary, they should contain anything sound, they will be freed here in the most efficacious way from their inexact and inconsistent components, so as to take the shape fittest for lasting use in science. And now let us go into the matter.

The first concept we start from is *equilibrium*. In its original meaning, this word expresses the state of a balance when two loads are of the *same weight*. Later, the conception was transferred to forces of all kinds, and designates the state when the forces neutralise one another in such a way that *no motion* occurs. As the result of the so-called chemical forces does not show itself as a motion, the use of the word has to be extended still further to mean that *no variation* occurs in the properties of the system. In its most general sense, *equilibrium denotes a state independent of time.*

For the existence of such a state it is above all necessary that temperature and pressure shall remain constant; in consequence of this, volume and entropy remain constant too. Now it is a most general experimental law, that the possibility of such a state, independent of time, is dependent on the *homogeneity* of the system. In non-homogeneous bodies, as, for instance, in a solution of different concentration in different places, or in a gaseous mixture of different composition in different places, equilibrium cannot exist, and the system will change spontaneously into a homogeneous state. We can therefore limit our considerations to this state, and we shall consider only bodies or systems of bodies in equilibrium, and, consequently, homogeneous.

Perhaps the possibility of the existence of water in contact with water-vapour might be considered contradictory to this statement, because we have here two different states and no homogeneity. Here we meet with the new concept created by Willard Gibbs, namely, that of a *phase*.

Systems of this kind are formed of homogeneous bodies indeed, but of more than one. The water in our system is homogeneous in itself, and the vapour too, and equilibrium cannot exist until both are homogeneous. But there is a possibility that a finite number of different homogeneous bodies can exist together without disturbing one another. In such a system we must have the same temperature and the same pressure everywhere, but the specific volume and the specific entropy may change from one body to the other.

We call a *phase* every part of the system where these specific properties exhibit the same value. It is not necessary that a phase should be connected to one body only; it may be distributed over any number of parts. In this way the millions of globules of butter in milk form only *one* phase, and the watery solution of casein and milk-sugar forms a second phase: milk is a two-phase system.

Every system consisting of only one phase has two degrees of freedom. This law involves only the assumption that the sole forms of energy involved in the system are heat and volume-energy; we exclude from consideration any effects due to gravitation, electricity, surface-tension, &c. This law is connected with the famous phase rule of Willard Gibbs, but is not identical with it, for it contains no mention at all of the so-called components of the system. Indeed, the law is valid in the same way for any pure chemical element, for example, oxygen, or for any mixture, for example, a glass of whisky and water. If you allow to the latter only one phase, it is impossible to change it in more than two ways, namely, in pressure and temperature.

The existence of such a body in the shape of only one phase is generally limited. If the pressure be lowered at constant temperature, a liquid or a solid will change at last into a gas. Lowering of temperature will change a gas into a liquid and a liquid into a solid. For every one-phase system it is possible to determine a "sphere of existence." This sphere is not necessarily limited on all sides; for gases we do not expect a limit on the side of low pressures and high temperatures, nor for solids on the side of high pressures and low temperatures. But on certain sides every phase has its limits, and most of these limits are experimentally accessible.

What will happen if we exceed the limit of existence of a phase? The answer is most simple: *a new phase will be formed.* The spheres of existence of the different phases therefore limit one another, and the boundary-lines represent the interdependent values of temperature and pressure for the possibility of the co-existence of both phases.

By granting the co-existence of two phases we lose therefore one degree of freedom. At the same time a new variation has arisen from the ratio between the masses of the two phases. For we must not suppose that this ratio is without influence on the state; indeed we find here two radically different cases.

The most general case is, that during the transformation of one phase into another the properties of both are continually changing, and the state of every phase is therefore dependent on the ratio of the two masses. By evaporating sea-water at constant temperature the density of the residue grows continually higher, while the pressure, and therefore the density, of the vapour goes on decreasing. If, however, we evaporate distilled water, we do not find any change in

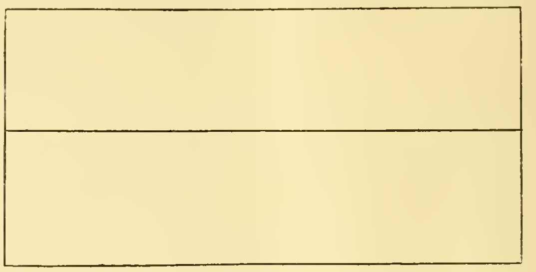

FIG. 1.

the properties of the residue and of the vapour during the whole transmutation.

Bodies of the first description we will call *solutions*, and of the second, *hylotropic bodies*. You will be inclined to call the latter substances or chemical individuals, and indeed both concepts are most nearly related. However, the concept of a hylotropic body is somewhat broader than that of a substance. But the possibility of being changed from one phase into another without variation of the properties of the residue and of the new phase is indeed the most characteristic property of a substance or chemical individual, and all our methods of testing the purity of a substance or of preparing a pure one can be reduced to this one property; anyone may readily convince himself of this by investigating any such method in the light of this description.

If we represent these cases by means of rectangular coordinates, taking as abscissæ the part of the first phase converted into the second, and as ordinates pressure or temperature, we get Fig. 1 for hylotropic bodies; they are represented by a horizontal straight line. With a solution we get a continuous line too, but not horizontal and generally not straight. If the ordinates are pressures at constant temperature, and the change is from liquid into vapour, the line will slope downwards as Fig. 2 shows. At other temperatures the lines will be of similar shape, only lying higher at higher temperatures and *vice versâ*. With other changes we obtain similar lines, sloping upwards or downwards as the case may be. For simplicity's sake we will consider in the future only vaporisation; this case gives the greatest possible variety, and we are sure not to omit anything by such a limitation.

What is the general process of change in a solution while it is being vaporised? The answer is quite distinct: *the residue is always less volatile* than the original solution, and *the distillate more volatile.* If there were an example of a solution behaving in the contrary way, then the process of vaporisation at constant temperature would be an explosive one. For the vapour begins to form at a given pressure; if by this the vapour-pressure of the residue were lowered, the vaporisation would continue of itself at a continually accelerated rate until all the liquid would be vaporised at once. It would be, in other words, a *labile* equilibrium. These equilibria are, however, only mathematical fictions, and have no experimental existence. If, on the contrary, the residue has a lower vapour-pressure, then the process is self-limiting, and shows the characteristics of a *stable* equilibrium. With hylotropic bodies we have an *indifferent* equilibrium, because the state is independent of the progress of the transmutation.

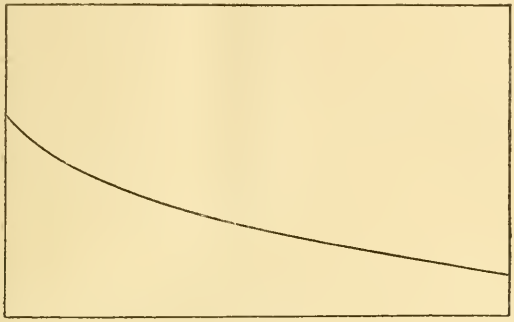

FIG. 2.

This being granted, we can ask: if we continue the separation of a solution into a less and a more volatile part by repeated distillation, what will finally become of it? Generally considered, two cases may happen. First the residue may become less and less, and the distillate more and more volatile, and there is no end to the progress. This case we may exclude from experimental evidence of a most general character, for we may take it as a general law that it is impossible to enhance any property beyond all limits, even by the unlimited application of our methods. We must conclude, therefore, that we shall ultimately meet with a *limit of volatility on both sides*, that finally we shall have separated our solution into a least and a most volatile part, and that both parts will not change further by repeated distillation. This is a most interesting result, for it means that *every solution can be resolved into components, which are hylotropic bodies.* For simplicity's sake we have considered only the case that two hylotropic components are generated by the process of separation; generally more than two may be formed, but in every case only a limited number of such components is possible. We may formulate therefore as a general law:—

It is possible in every case, to separate solutions into a finite number of hylotropic bodies.

From the components, we can compose the solution again with its former properties. This is also a general experimental law; if exceptions seem to exist, it is only because the case is not one of true equilibrium. Still we may limit our consideration to those cases where the law holds good. Then we have a relation between the properties of any solution, and the nature and relative quantity of its hylotropic components, which admits of only one interpretation. Every solution of distinct properties has also a distinct composition and *vice versâ*.

If we consider for simplicity's sake solutions of only *two* components, we may represent any property as depending upon the composition in a rectangular coordinate system, the abscissæ giving the composition and the ordinates the value of the property considered. In this way, we get a continuous line of a shape dependent on the particular case chosen.

If we consider the boiling points of all solutions formed by two hylotropic components, the most simple forms of curves (indeed the only experimental ones known) are given by the types I, II, and III, Fig. 3. For any solution, for example, the solution with the abscissa a, we can foretell its variation on distillation by the slope of the curve. For, as the residue must be less volatile, the residue will change to the ascending side of the curve. This is for I and III to the right, for II to the left side of the diagram. The change of the *distillate* is the opposite.

If we try to apply this criterion to the points m of the curve II and III, where there is a maximum and a minimum of the boiling point, we arrive at no decisive answer, for if the boiling point is already the highest possible it cannot rise, and if it is the lowest possible it cannot fall. We are forced therefore to conclude that the boiling point cannot change at all, that is, that this special solution must behave as a hylotropic body.

This is a well known theorem of Gibbs and Konovaloff, to wit, that a maximum or a minimum, generally spoken of as a *distinguishing point* in the boiling-curve, is necessarily connected with the property of distilling without change in the composition of the solution. A similar law holds good for the transitions from liquid to solid and from solid to gas.

Now this looks like a contradiction; while a few minutes ago we placed solutions in a class exclusive of hylotropic bodies, we have here solutions, that is, mixtures, which behave like hylotropic substances. But the contradiction vanishes if we consider a series of boiling-point curves corresponding to various pressures. We then find that the composition at the distinguishing point does not remain constant under different pressures, but shifts to one side, with alteration of pressure. This fundamental fact was discovered and experimentally developed in an admirable way by Sir Henry Roscoe, and has since proved itself a most important criterion in recognising a chemical individual.

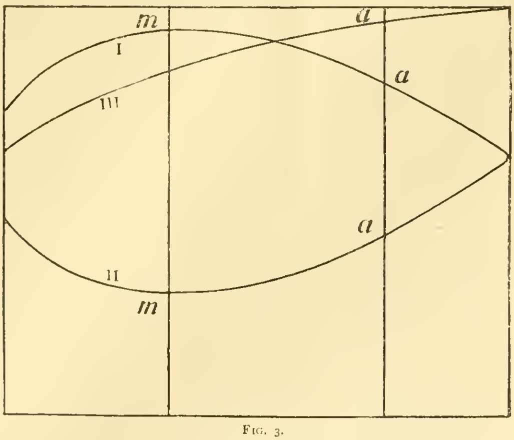

FIG. 3.

By drawing curves corresponding to various pressures, we get therefore generally the diagram shown in Fig. 4, the loci of the distinguishing points forming one curve. Between

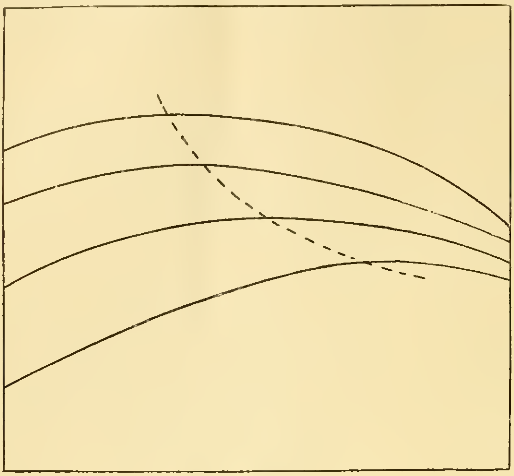

FIG. 4.

the infinite possibilities of the shape of this curve we have a distinguishing case again, the case that the curve is a *vertical straight line.* This means that the composition is independent of the pressure. *When this is the case, we call this hylotropic body a substance or a chemical individual.*

Therefore we conclude that a connection exists between solutions and chemical compounds or substances, the latter being a distinguishing case of the former. On the other hand, we get an exact definition: *a substance or a chemical individual is a body, which can form hylotropic phases within a finite range of temperature and pressure.*

Such substances can often be produced from other substances in the same way as a solution is, namely, by putting them together. If that can be done, we may infer from our definition that there exists a definite ratio between the components, independent of temperature and pressure between certain limits.

Now, *this is essentially the law of definite proportions*, the first of the stoichiometrical laws. We have deduced, therefore, the law of constant proportions from the concept of the chemical individual.

As you have seen, this deduction is extremely simple; the constancy of composition is a natural consequence of the mode of preparation and purification of chemical substances.

If we exceed the limits of temperature and pressure, where the body behaves as a hylotropic one, it assumes the properties of a solution, that is, its distinguishing point begins shifting in composition when the temperature is changed. Then it becomes possible to separate the body into its components, and we call this state the state of dissociation of the substance in question. In our graphic representation, the hitherto straight vertical line of distinguishing points turns sideways, Fig. 5. Most substances behave in this way, but there are substances which have never been transformed into solutions or the sphere of existence of which covers all accessible states of temperature and pressure. Such substances we call elements. In other words, *elements are substances which never form other than hylotropic phases.*

From this we may conclude that every body is finally transformable into elements, and into only *one definite set of elements.* For the most general case is a solution. Every solution can be separated into a finite number of hylotropic components, and these again can generally be transferred into a state when they behave like solutions and can be separated further. Finally, the components remain hylotropic through the whole range of temperature and pressure, that is, they are elements.

From the fact that the relation between a compound substance and its elements admits of only one qualitative and quantitative interpretation, we derive the conclusion that the resolution of any substance into its elements must always lead to the same elements in the same proportion. Here we find the source of the law of the *conservation of the elements.* This law is not generally expressed as a special stoichiometrical law, because we tacitly infer it from the atomic hypothesis. But it is truly an empirical law, and we see that it is not only a consequence of the atomic hypothesis, but also a consequence of the experimental definition of an element and of our methods of obtaining elements.

Here I should like to pause for a moment for the purpose of quoting a couple of historical facts. Up to the present moment, the question whether it is possible to deduce the stoichiometrical laws without the help of the atomic hypothesis has only been raised by other investigators in order to deny the possibility. So far as I am aware, there exists only one man who has worked upon the question with the earnest hope of obtaining an affirmative answer. Very few

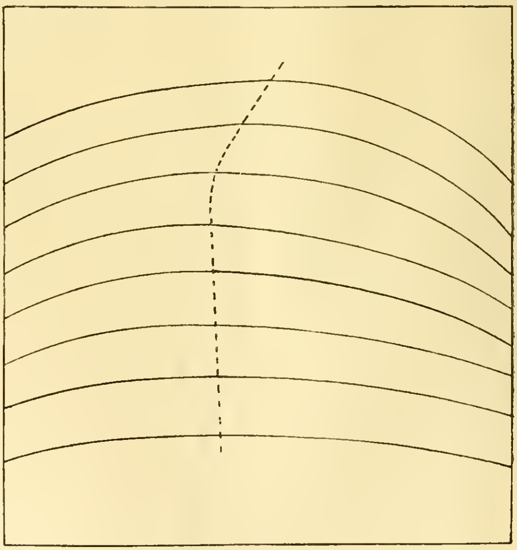

FIG. 5.

know his name. The man is Franz Wald; he is chief chemist at the iron works in Kladno, Bohemia. His papers on the subject are to be found in the *Zeitschrift*

für physikalische Chemie and in the *Annalen der Naturphilosophie*.

In the foregoing considerations, Franz Wald has played a great part. To him I owe first the idea that the definition of substances and elements is in a certain sense arbitrary, though very helpful and convenient. This definition is a condensed expression of our methods of separating and purifying these bodies. While, generally speaking, every solution has the same claim to be investigated as these bodies, the latter soon distinguish themselves as standards to which all other cases may be referred. To Franz Wald I owe further the idea that the conception of a *phase* is a far more general one than that of a substance, and that the deduction of the idea of a substance, and, further, the deduction of the laws governing the nature of substances, must start from the conception of the phase. I do not know whether Wald will agree with the way I have manipulated his ideas, but I feel it imperatively necessary to express my deep respect for, and my thankful obligation to, this solitary philosopher, who has prosecuted his work during a long series of years almost wholly without encouragement or sympathy from others.

Now there are still two stoichiometrical laws to be deduced, namely, the law of multiple proportions and the law of combining weights. I prefer to invert the order, and first to deduce the second law. It expresses the fact that it is possible to ascribe to each element a certain relative weight in such a way that every combination between the elements can be expressed by these weights or their multiples.

We suppose three elements, A, B, and C, given, which may form binary combinations, AB, BC, and AC, and besides these a ternary combination, ABC; there shall be but one combination of every kind. Now we begin by forming the combination AB; for this purpose, we must take a certain invariable ratio between the weights of A and B, according to the already proved law of constant proportions. Now we combine AB with C and get the ternary compound, ABC. There will be a certain ratio, too, between AB and C, and we can, if we put A as unity, assign to B and C certain numbers describing their combining weights relatively to A.

Now we begin to combine A with C forming AC, and then we form the ternary combination, ACB from AC and B. According to our law of a relation between elements and compounds, which can be interpreted only in one way, ACB cannot be different from ABC, and, in particular, it must show the same ratio between the relative weights of its elements. Therefore, the ratio of the weights of A and C in forming the combination AC cannot be other than that expressed by the relative combining weights already found in the first way. In other words, it is possible to compute the composition of the hitherto unknown combination AC, from analyses of the combinations AB and ABC. In the same way, we can compute the composition of the unknown combination BC, by help of the numbers obtained by the analyses of two other combinations of the same elements. To resume: the combining weights relatively to A regulate all other possible compounds between the elements concerned. But this is nothing else than the general stoichiometrical law of combining weights, for we can extend our considerations without difficulty to any number of elements.

Lastly, it is easy to deduce the law of multiple proportions from the law of combining weights. If no compounds can be formed except according to their combining weights, then, if there are two different compounds between A and B, we can form the one containing more of B either directly from A and B, or indirectly, combining first A and B to form the lower compound and then combining this with more of B. In applying the law of combining weights, we conceive that the weight of B in the higher compound must be twice its weight in the lower. The same consideration may be repeated, and finally we get the result, that instead of double the combining weight, *any multiple* of it may occur in combinations, but no other ratio.

If we cast a backward glance on the mental operations we have performed in the last two deductions, we recognise the method, the application of which has made the two laws of energetics so fruitful. In the same manner as the difference between the whole and the available energy is independent of the nature of the path between the same limiting points, the product of the chemical action between a number of given elements is independent of the way in which they are combined. If we compare two different ways, we get an equation between the characteristics of the two ways, and this is equivalent to a new law. In our case, this new law is the law of combining weights.

I will put the same idea into somewhat different words. By stating the equation between any two ways, we can get any number of different equations, each representing a new way as an experimental fact. Now, in order that all these equations shall be consistent, there must be some general law regulating the characteristics of the equations. For the consistency of the several equations in the case under discussion, the existence of specific combining weights, independent of the several combinations, is the necessary condition.

This is the main point of the considerations I wish to lay before you this evening. There are some secondary questions as to isomerides or allotropic states of substances, and there are other similar questions, but it would lead us too far to consider them one by one. I have investigated them on the same basis, and I can assure you that I have nowhere found an insurmountable difficulty or an impassable contradiction. All these facts find their proper place in the frame of the same general ideas.

Let me still add some words about the *nature of the elements*, as considered from my point of view. I wish to lay great stress on the fact that here, too, I find myself on the same ground as that on which Faraday built his general concepts during his whole scientific career. There is only one difference, due to the development of science. Faraday ever held up the idea that we know matter only by its forces, and that if we take the forces away, there will remain no inert carrier, but really nothing at all. As Faraday still clung to the atomic hypothesis, he was forced to express this idea by the conception that the atoms are only mathematical points whence the forces emerge, or where the directions of the several forces intersect; here his view coincided with that of Boscovich.

In the language of modern science I express these ideas by stating: *what we call matter is only a complex of energies which we find together in the same place.* We are still perfectly free, if we like, to suppose either that the energy fills the space homogeneously, or in a periodic or grained way; the latter assumption would be a substitute for the atomic hypothesis. The decision between these possibilities is a purely experimental question. Evidently there exist a great number of facts—and I count the chemical facts among them—which can be completely described by a homogeneous or non-periodic distribution of energy in space. Whether there exist facts which cannot be described without the periodic assumption, I dare not decide for want of knowledge; only I am bound to say that I know of none.

Taking this general point of view, in what light do we regard the question of the elements? We will find the answer, if we remember that the only difference between elements and compounds consists in the supposed impossibility of proving the so-called elements to be compounds. We are therefore led to ask for the general energetic properties underlying the concept of a chemical individual, whether element or compound.

The answer is most simple. The reason why it is possible to isolate a substance from a solution is that the available energy of the substance *is a minimum*, compared with that of all adjacent bodies. I will not develop this thesis at length, for it is a well known theorem in energetics or thermodynamics. I will only recall the fact that a minimum of vapour pressure is always accompanied by a minimum of available energy; and we have already seen that a minimum of vapour pressure or a maximum of boiling point is the characteristic of a hylotropic body or chemical individual.

This granted, we proceed to the question regarding the differences between the several substances. Expressed in the most general way, we find these differences connected with differences in their *specific energy content*. Temperature and pressure are not specific, for we can change them at will. Specific volume and specific entropy, on the contrary, are not changeable at will; every substance has its own

values of these. We may take therefore these values as the characteristics of the different substances. How many of such characteristics exist I cannot tell. Only for simplicity's sake I will assume that two of them are sufficient. As I will take care not to deduce any conclusions from this number, we shall not be led into error by accepting it.

We place these two characteristics in a system of planar coordinates; then the several elements will be represented by single points in the plane. We lay the plane horizontally and raise from these points ordinates, representing the available energy of each element. Between the points of the elements in the plane are situated the points of all possible solutions, filling up the whole plane. Each of these solutions will also have its available energy, and all the corresponding points in space will form a continuous surface. The form of this surface can be described in a general way. For as each *element* has its point in a *relative minimum*, the surface as a whole will have a shape like the ceiling of a cavern full of hanging stalactites, the end of each stalactite representing an element.

How can we pass from one element to another? Evidently not otherwise than by going over the higher parts of the surface, or the passes separating each stalactite from its neighbours. This can only be done by accumulating an appropriate amount of available energy in the element to be changed. Now the concentration of energy is a task we cannot accomplish *ad libitum*, for the possibility very soon ends. Think, for example, of compressing a gas into a given space. Up to some ten thousand atmospheres the work of compression will go on smoothly, but after that every metal begins to flow like a liquid, and you cannot proceed further. With the concentration of electric or any other energy the task is similar, and so we come to the conclusion that the concentration of energy can be pushed to only a very limited extent. The application of this result to our question about elements is simple enough: we cannot get over the pass between two stalactites because we cannot attain the necessary concentration of energy.

From the history of science we learn that these considerations contain at least some truth, for the isolation of the elements has ever been dependent upon the power of concentrating energy available at that time. The most brilliant example is the application of the voltaic pile to the isolation of the alkali metals by Humphry Davy.

Still I must confess that these last considerations are in a very embryonic state, and I should not have brought them before you if an unexpected application had not lately made itself manifest. Some years ago I explained these views to my old friend Sir William Ramsay, when he asked me how the idea of elements fitted into my conceptions of energy. Then I forgot all about it until Sir William reminded me of it, saying that his perplexing discovery of the transmutation of radium into helium might conceivably find some explanation in this way. This I am convinced of, and the considerations may be pictured in the following manner.

In the corner of our cavern where the elements with the highest combining weight are assembled, the stalactites are very short; and at last they are not really stalactites, but rather regions of different slope in the sloping ceiling. Where the plane is nearly horizontal a drop of water furnishes a picture of the stability of the elements. While hanging at the end of a true stalactite, more or less work must be done to raise the drop over the pass until it flows down another stalactite. But in this corner it will flow of its own accord, and only delay for a short time on the nearly horizontal portions in the ceiling.

Such elements will have only a *temporary existence*. Now we are sure that for the transmutation of one element into another enormous amounts of energy would be required, for the concentrations of energy as yet available have proved themselves insufficient for this purpose. We may expect, therefore, that enormous amounts of energy will be liberated if such an unstable element changes into a stable one. This accounts for the extraordinary quantity of energy developed by radium during its existence. The fact that radium changes into helium, an element with an exceptionally long stalactite (for it is impossible to get even any combination of helium), makes us expect indeed such an unusually great development of energy as is found to occur.[1]

The heat from radium is surely only the last form of the energy developed in its transformation. There are a great many intermediate forms, termed rays or radiations, which have been studied by a band of eminent workers, whose ingenuity and ability have been displayed in the most brilliant way during these investigations. Perhaps I may venture the suggestion that first, other intermediate temporary elements are formed, and that the energy liberated at this transmutation appears first in the shape of *new*, still imperfectly known forms. It is most likely that such forms are originated during the decay of the enormously concentrated energy of radium; at the same time it is probable that we have not yet the means of fixing these forms and so preventing their changing into other more common forms. We should remember that, for example, the conservation of electric energy at a pressure of some thousand volts during some months or years is by no means an easy thing, and I have great doubt if it is possible at all.

But here I must conclude, for I have ventured to intrude on a field where I have not secured my own right of entry by personal work. I see among my audience men who are possessed of an incomparably more minute and comprehensive knowledge of these new realms of science than I. I must ask you, therefore, to take these suggestions in the same spirit as that in which Faraday took his own speculations. They are questions put to nature. If she says Yes, then we may follow the same path a little further. If she says No—well, then we must try another path.

[1] Compare Soddy, "The Wilde Lecture," *Mem.* and *Proc.* Manchester Lit. and Phil. Soc., 1904. I am very glad to find that I am in close agreement (except in so far as there is a difference in his accepting the atomistic, while I hold by the energetic point of view) with this most zealous and fortunate worker; indeed, the above statements were written and printed before I saw Mr. Soddy's lecture.

A SMITHSONIAN MAGAZINE OF SCIENCE.

TO provide a medium for the early publication of the results of researches conducted under the auspices of the Smithsonian Institution, and especially for the publication of reports of a preliminary nature, a quarterly issue of the *Smithsonian Miscellaneous Collections* has been commenced. This new periodical has the form of an attractive magazine, and contains papers on a variety of subjects of scientific interest, most of them beautifully illustrated.

The number opens with a description of seventy new Malayan mammals, by Mr. Gerrit S. Miller, jun., based on collections made and presented to the U.S. National Museum by Dr. W. L. Abbott. Mr. C. G. Abbot presents the results of recent studies of the solar constant of radiation, conducted at the Astrophysical Observatory of the Smithsonian Institution, under the direction of Dr. S. P. Langley. Another paper by Mr. Abbot describes the new cœlostat and horizontal telescope of the Astrophysical Observatory, in which are given the results obtained with a device designed by Dr. Langley for the purpose of "churning" a column of air traversed by a solar beam, with the view of reducing the "boiling" or confusion of all parts of the solar image due to variability of the strata of air traversed. Dr. F. W. True presents some photographic illustrations of living finback whales from Newfoundland, these being the first photographs of living whales in American waters that have thus far been published. Brief descriptions of a skeleton of Hesperornis, and a new Plesiosaur, by Mr. Frederic A. Lucas, are given with plates, and Mr. W. H. Holmes illustrates and compares the designs on some remarkable shell ornaments from Kentucky and Mexico.

A noteworthy specimen of a Glacial pothole in the National Museum is described by Mr. George P. Merrill, who explains the method by which the specimen was procured. Some notes on the herons of the district of Columbia, by Mr. Paul Bartsch, who made a systematic survey of two heron colonies and conducted experiments with the view of solving some of the problems of bird life, are of special interest. Dr. J. Walter Fewkes gives a preliminary report on an archæological trip to the West Indies

in 1903, describing particularly the remarkable objects of stone, bone, shell, wood, and pottery which he collected during the trip, and giving an insight into their various uses. Dr. C. M. Child, of Chicago University, describes the form-regulation in Cœlentera and Turbellaria, of which he made a special study during his occupancy of the Smithsonian table at the Naples Zoological Station, and Dr. Carl H. Eigenmann introduces some new genera of South American fresh-water fishes, and new names for some old genera. Of timely interest is the account of Korean headdresses in the U.S. National Museum by the late Mr. F. H. Jenings, in which are described and illustrated twenty-four varieties of Korean hats and other headgear, including headband buttons and hatpins for topknots.

A brief history of the Hodgkins Fund of the Smithsonian Institution, and of what has been accomplished with its income toward "the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man," bears the name of Helen Waldo Burnside, and is accompanied with an illustration of the beautiful Hodgkins medal. Mr. A. B. Baker gives an account of a notable success in the breeding of black bears, which is of special interest to those having charge of animal collections. In a contribution on Chinese medicine, Dr. James M. Flint briefly explains the origin of medicine and the theory of disease in the Celestial Empire. The last of the series of articles consists of notes on the rocks of Nugsuaks Peninsula and its environs, Greenland, by Mr. W. C. Phalen, the remaining pages of the magazine being occupied by brief descriptions of various activities of the institution and their results.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is a copy of the speech delivered on April 28 by the Public Orator, Dr. Sandys, in presenting Prof. Ostwald, of Leipzig, for the degree of Doctor in Science *honoris causa*.

Viri et rerum naturae in scientiis excolendis et scientiarum illarum in terminis propagandis prospere occupati, non unius tantum populi intra fines angustos cohibentur, sed orbis terrarum totius inter cives merito numerantur. Nuper apud Londinienses Faradaii nostri memoriam oratione luculenta prosecutus est vir scientiarum laude illustris, qui a Germanis olim oriundus, Germanorum ultra terminum orientalem Russorum in imperio natus et professoris officio functus, postea in ipsam Germaniam atque adeo ad universitatem insignem Lipsiensem vocatus, in scriptis suis omnibus Germanorum gravitatem cum Francogallorum stilo lucido consociavit. Idem ne Europae quidem terminis contentus est, auctumno proximo (nisi fallor), velut alter Mercurius, Atlantis nepos facundus, etiam aequor Atlanticum transiturus. Quanta diligentia, memoria quam tenaci, ingenio quam multiplici praeditus, scientiae chemicae et scientiae physicae confinia quam diu quam feliciter lustravit, a collegis magnis sine ulla invidia peregre laudatus, a discipulis plurimis in omni orbis terrarum regione dilectus. Quot opera, inter sese quam varia, scientiae suae explicandae destinavit; idem etiam aliorum labores in Actis a sese tam diu editis quam diligenter in unum collegit, collectos in ordinem quam perspicuum redegit. Nemo mirabitur Actorum illorum librum prope quinquagesimum viri tanti in honorem nuper esse dedicatum, qui abhinc annos fere quinquaginta natus, vitae suae iam per partem dimidiam doctoris nomine decoratus est. Virum talem ad litora nostra honoris causa nuper vocatum, etiam nostro doctoris titulo libenter ornamus.

A COMBINED examination of non-resident candidates for open scholarships, exhibitions, &c., will be held at Trinity College, Clare College, Trinity Hall, Peterhouse, and Sidney Sussex College, Cambridge, beginning on Tuesday, December 6. Candidates will be examined at each college at the same time and by the same papers. Forms of application for admission to the examination may be obtained from any of the Tutors of Trinity College, the Senior Tutor of Clare College, the Master of Trinity Hall, the Senior Tutor of Peterhouse, or the Master of Sidney Sussex College. Entries should be made not later than November 18. Papers will be set in classics, mathematics, natural sciences, moral sciences and history. In mathematics and science the range of subjects included in the examination will be as follows:—*Mathematics*.—Arithmetic, geometry, algebra, trigonometry, elementary statics and dynamics, conic sections treated both geometrically and analytically, and the elements of the differential calculus. *Natural Sciences*.—Physics, chemistry, zoology, botany, physiology, and geology. Candidates for an emolument at Clare College may also offer elementary biology as a subject. Of these subjects no candidate may offer more than three. In making awards, excellence in one subject or in two subjects will be taken especially into account. There will also be (1) a paper of general questions in natural sciences which must be taken by all candidates who offer natural sciences, and (2) an optional paper in mathematics suitable for candidates who offer physics as one of their subjects.

THE Education Bill for Scotland was read a second time in the House of Commons on Monday by a majority of fifty-seven.

A LIST of the courses of lectures proposed for the summer term in the various German-speaking universities and technical schools is given in the *Physikalische Zeitschrift* for April 15.

THE foundation-stone of an extension of the Durham College of Science, Newcastle-on-Tyne, was laid on Monday by Mr. T. G. Gibson. The cost of the new buildings has been provided by a fund of 50,000*l*., raised to commemorate the life of the first Lord Armstrong, whose name the college will henceforward bear.

A COURSE of ten advanced lectures on the "Tracts of the Brain," by Dr. W. Page May, was commenced yesterday at University College, and will be continued on Wednesdays at 5 p.m. The lectures are open without fee to all internal students of the university.

THE following appointments are announced:—Dr. Friedrich Engel, of Leipzig, professor of mathematics in Greifswald; Dr. J. Schubert, of Eberswald, professor of physics, meteorology and geodesy; Dr. K. Hopfgartner, of Innsbruck, professor of chemistry; Dr. K. Schaum, of Marburg, extraordinary professor of physical chemistry; Prof. Paul Behrend, of Hohenheim, professor of organic chemistry; Prof. Lorenz, of Göttingen, ordinary professor of mechanics; and Prof. Roessler, of Charlottenburg, professor of electrotechnics—the last three at the Danzig Technical School; Dr. A. Hagenbach, professor of physics at Aachen; Prof. Moersch, professor of engineering at Zurich; Dr. Wedekind, of Tubingen, and Dr. Otto Dimroth, extraordinary professors.

REPLYING to a question in the House of Commons on April 27, Mr. Brodrick said that papers would shortly be laid on the table relating to the subject of the further maintenance of Coopers Hill College, including the report of the committee which sat last year. In consequence of the strong recommendations of that committee and the evidence brought before them, that efficient candidates for the Public Works Department in India can be provided by other engineering colleges at a less cost to the candidates and to the Indian Government, it has been decided to close the college. No decision, however, has yet been arrived at as to the date of closing, and all possible consideration will be shown to those concerned.

IN his presidential address at the recent annual general meeting of the Institute of Chemistry, Mr. David Howard reviewed the work of the council of the institute during the past year. Among other matters of interest he referred to the work of a special committee appointed to consider the advisability of instituting examinations for technical chemists. Mr. Howard said the most common difficulty at present is how to bridge over the gap between the scientific training and the practical work of the technical chemist. "What the chemist has to learn is to think in tons, not in grams." A large number of well known manufacturers consulted by the committee, while agreeing as to the value of a sound training in chemistry and physics, were emphatic that they did not want chemists trained or examined in the special technology of particular industries. The scheme drawn up by the committee is, as far as

possible, based on the opinions of the manufacturers. As Mr. Howard said, it is gratifying to know that in this investigation the institute can rely on the cooperation of so many leaders of industry, among whom are ironmasters, alkali, acid and general chemical manufacturers, brewers, cement makers, and representatives of dyeing, calico printing, and other important industries. A technical chemist possessing all the qualifications suggested by the manufacturers would be at once a competent mechanical engineer, electrical engineer, architect and surveyor, accountant and book-keeper, draughtsman, patent agent, and lawyer, in addition to being a capable chemist, and he would possess also special personal qualities, including the power of organisation, tact and general business capacity. The committee is strongly inclined to think that it is possible so to direct the post-graduate studies of the young chemist that he may adapt himself to technical practice, and thus not only improve his own position, but be better qualified to bear his part in the prevailing struggle of industry.

The King on April 28 laid the first stone of the new buildings for the Royal College of Science, Ireland, which are situated at Leinster Lawn, Dublin. The ceremony was commenced by the reading of an address by Sir Horace Plunkett, vice-president of the Department of Agriculture and Technical Instruction for Ireland, reviewing the work of the department as a whole, and especially that part of it entrusted to the Royal College of Science for Ireland. Referring to the latter, the address comments on the assistance received by the department from local authorities in the work of developing a system of technical instruction throughout Ireland, and points out the national value of a complete system of education. The King, in reply to the address, expressed his pleasure at performing the ceremony, and continued :—" In these days scientific training is an indispensable condition of success in commercial and industrial life. To be thoroughly effective it requires all the help which research and modern appliances can give. You are therefore wise in providing the improved equipment and the widened opportunity for instruction which this college will henceforth supply. You have told me that the efforts of your department to extend scientific education among the people have been supported by popular sympathy, and by the cooperation of representative public bodies. I am glad to receive this assurance; for without such sympathy and cooperation any scheme of technical instruction, however well devised, must fail to come into close touch with the life of the people, and must fall short of complete success. I agree with you in thinking that a complete system of education is necessary for the full realisation of your aims; and my best wishes go with your efforts to improve the intellectual and material conditions of the country." During his Irish visit the King also took another opportunity of emphasising the value of education in assisting the development of a country. At Kilkenny, in reply to addresses from a number of bodies, including the Kilkenny Agricultural Society, His Majesty said :—" I notice with pleasure the earnest efforts which are now being made for the industrial development of Ireland, and especially for the promotion of the agricultural industry, in which I take great practical interest. Agricultural prosperity, in my judgment, depends largely upon improved educational methods, cooperation, and better facilities for distributing produce. I am glad to know that, along these lines, progress is now being made in Ireland."

SOCIETIES AND ACADEMIES.

London.

Linnean Society, April 21.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. Clement **Reid** exhibited drawings by Mrs. Reid of fruits and seeds of British pre-Glacial, inter-Glacial, and Roman plants: 2nd series—Calyciflorae. The most interesting addition to the inter-Glacial flora is the south European *Cotoneaster Pyracantha*, which occurs abundantly on the Sussex coast in deposits which yield also *Acer monspessulanum*, *Najas minor*, and *N. graminea*. The pre-Glacial Calyciflorae include *Trapa natans*, but the rest of the species yet determined are still living in Britain; many, however, need further examination. The plants from Roman Silchester include the vine, bullace, damson, and coriander.—Dr. O. Stapf, on behalf of Mr. W. B. **Hemsley**, exhibited some specimens of *Primula vulgaris*, Huds., which displayed the phenomenon of phyllody of the calyx in an unusual degree.

Physical Society, April 22.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—Calculation of colours for colour sensitometers and the illumination of "three-colour" photographic transparencies by spectrum colours: Sir W. de W. **Abney**. In three-colour photography, photographs have to be taken through a red, a green, and a blue screen, the transparencies or prints from which are then viewed. The exact shades and hues of these screens depend on the light which is used for viewing the transparencies or on the colours employed in printing. The present paper confines itself to the former case.—Normal piling as connected with Osborne Reynolds's theory of the universe: Prof. J. D. **Everett**. The paper maintains that, in a struggle for existence between different kinds of closest piling, represented by separate clusters with room to change their arrangements, normal piling possesses great advantages, first, in its six sets of lines of spheres, which serve as battering rams, and secondly, in its four sets of tiers in closest array, which facilitate the coalescence of adjacent clusters.—Note on the diffraction theory of the microscope as applied to the case when the object is in motion: Dr. R. T. **Glazebrook**. According to the Abbe theory of microscopic vision, when a grating is placed on the stage of a microscope and illuminated by plane waves, diffraction images are formed in the focal plane of the object-glass and the images in the view-plane result from these, and this is undoubtedly true. It is proved in this paper that the image in the view-plane may change without an alteration in the *position* of the diffracted images.—An "automatic gas-pump" was exhibited by Mr. C. E. S. **Phillips**. The apparatus is constructed upon a plan which enables the pump, when once set in operation, to continue automatically and to produce as perfect a Torricellian vacuum as is possible.

Edinburgh.

Royal Society, March 21.—Prof. Flint in the chair.—Dr. J. Erskine **Murray** exhibited and explained a differentiating machine, by means of which the first derivative of a given curve could be traced mechanically. A rod A is pinned at one end to a rectangular frame so as to be capable of revolution in the plane of the frame. A second rod B is retained by guides on the frame so as to be capable of motion only in the direction of its length. A pin in B engages in a longitudinal slot in A, and thus the distance between B and the pin about which A revolves is constant. The displacement of B relatively to the frame is therefore proportional to the tangent of the angle of inclination of A. If the revolving rod A be guided by hand so as to be always tangential to the given curve, a curve the coordinates of which are proportional to the differentials of the original curve is traced out by any point on B. The frame supporting the rods is free to move in direction X at right angles to the rod B. In order to eliminate the y-coordinate of the original curve, the board on which the derived curve is traced is free to move in OY but not in OX.—Dr. J. **Halm** gave an account of his spectroscopic observations of the rotation of the sun, which had been carried on at the Royal Observatory, Edinburgh, since 1901. The method employed was essentially that used by Duner, but some simplification and greater steadiness of the apparatus had been secured by the employment of a siderostat and heliometer. The results so far obtained seem to point to a decisive influence of solar activity upon the surface rotation. By arranging the results in two groups, one comprising the observations of 1901–2, a time of sun-spot minimum, and the other those of 1903, at a period of vigorously renewed solar activity, Dr. Halm obtained undoubted evidence of the existence of systematic differences between these two groups of quite unexpected magnitude. The decrease of angular velocity from the equator towards the poles, as observed in 1901–2, agreed very well with that found by Duner in 1887–9, also at a time of sun-spot minimum. But the appearance of spots in 1903 was accompanied by an extraordinary increase of angular

velocity in high latitudes. It seemed as if the spots had caused the superficial layers to rotate more in accordance with the law of rotation of a rigid body, a mode of statement, however, which was not to be accepted as involving any physical theory.—In a paper on the viscosity of aqueous solutions of chlorides, bromides, and iodides, Dr. W. W. **Taylor** and Mr. Clerk **Ranken** gave determinations of the relative viscosities of KCl, KBr, KI, HCl, and HBr, in solutions containing 1 mol., 2 mol., and 3 mol. per litre at 0°, 15°, and 25°. The effect of temperature change and concentration on the viscosity was found to be different for the chlorine, bromine, and iodine solutions. The molecular conductivities of the fifteen solutions at 0° were also determined, and showed no greater differences than for solutions of similar concentration at 18°.—In a note on the unit of relative viscosity and on negative viscosity, Dr. W. W. **Taylor** pointed out the disadvantages of expressing the relative viscosities of solutions by taking as unit the viscosity of the solvent at the temperature of experiment. Instead, they should all be referred to water at 0° as standard. Until quite recently only aqueous electrolytes were known to exhibit the phenomenon of "negative viscosity," *i.e.* the viscosity of the solution less than that of the solvent at the same temperature. According as the temperature coefficient of the solution is greater or less than that of the solvent, a solution may exhibit negative viscosity at high temperatures or at low temperatures.—In a paper on the action of chloroform on the heart and arteries, Prof. **Schäfer** and Dr. **Scharlieb** showed, as had been previously proved by Gaskell, McWilliam, Hill, Embley, Sherrington, and others, that chloroform has a powerfully paralysing action upon the mammalian heart, inducing in it a condition in which all irritability is lost, and is only recoverable by washing away the poison by passing a stream of unpoisoned blood or saline solution through the cardiac vessels. They further show that this paralytic condition is not due to vagal inhibition, which is only rarely to be seen in chloroform anæsthesia, and is then probably due to dyspnœa; it is therefore not capable of being antagonised by atropine. Even such a powerful agent as suprarenal medulla, which is one of the strongest cardiac stimulants known, is powerless to provoke contraction in a heart paralysed by chloroform. But sometimes artificial respiration by chest compression may, by inducing some sort of circulation through the coronary vessels, cause the removal of the drug from the heart. No benefit has been obtained by directly "massaging" the heart. The addition of a small percentage of ammonia vapour to the chloroform-laden air used for inhalation is shown to have a markedly beneficial effect upon the result, the heart's force and the blood pressure and respiration being maintained far better than with chloroform alone. Alcohol vapour has a similar but less marked effect. On the other hand, too large a proportion of ammonia vapour is liable to produce instant and permanent arrest of the heart's action. While the respiration usually stops before the heart, in some cases the cessation is simultaneous, and in a few the heart ceases before the respiration. After having completely stopped the heart may after a minute or two recommence to beat, but the respirations rarely begin again spontaneously, except that, as in asphyxia, a staircase of about a dozen respirations may make its appearance long after the ordinary respiratory movements have ceased. These are, however, ineffectual to produce recovery, and if artificial respiration be not resorted to the heart soon ceases permanently. The effect of chloroform upon the arterioles has been determined both in the frog and in the isolated mammalian kidney by perfusion of Ringer's solution containing dissolved chloroform. In the frog, solutions containing from 1 in 200 to 1 in 20,000 produce constriction of arterioles in proportion to the amount of chloroform contained in solution. In the mammal, while stronger solutions (such as 1 in 500) produce powerful constriction of arterioles, dilatation is obtained with weaker solutions (1 in 5000), a strength which in the frog produces marked contraction. This confirms an observation by Dr. C. J. Martin, recently communicated to the Physiological Society. Further experiments are needed to clear up this discrepancy between the results in the frog and mammal.—Mr. G. A. **Carse** communicated a paper on the thermal expansion of solutions of the hydroxides of sodium, barium, and strontium, in each of which the volume of the solution is less than that of the water used in its preparation. In the case of sodium hydroxide the expansion in all cases, whether positive or negative, increased algebraically with rise of temperature. The same was true for strontium hydroxide. In the case of barium hydroxide the expansion was so small and the variation with temperature so slight that nothing definite could be predicated, although all solutions examined agreed in giving negative expansion. With sodium hydroxide the maximum contraction point slowly shifted towards the concentration origin with rise of temperature.—Mr. John **Dougall** presented a complete and elaborate discussion of the analytical theory of the equilibrium of an isotropic elastic plate. The solution was obtained in the first instance for an infinite plate, and was then applied to cases of finite plates.—The Rev. F. H. **Jackson** communicated a theorem relating to a generalisation of the Bessel function.

PARIS.

Academy of Sciences, April 25.—M. Mascart in the chair. Report presented by the commission charged with the scientific control of the geodesic operations at the equator. A description of the work done during the year 1903, and a sketch of that proposed for 1904 and 1905. Unfavourable meteorological conditions interfered considerably with the work done last year.—M. Bigourdan was elected a member in the section of astronomy in the place of the late M. Callandreau, and M. Gordan a correspondant for the section of geometry in the place of the late Prof. Salmon.—Note on an earthquake at Roustchouk, in Bulgaria, communicated by the French consul.—Observations on the comet 1904 *a* (Brooks), made at the Observatory of Besançon: P. **Chofardet.** On April 19 the comet appeared as a star of the ninth magnitude, with a rounded head 1′ in diameter, and with a central nucleus. There was a slight tail from 2′ to 3′ in length in the direction of the south-west.—Observations on the comet 1904 *a* (Brooks), made at the Observatory of Paris: M. **Salet.**—Provisional elements of the Brooks comet (1904, April 16): G. **Fayet.**—The Leonids in 1903, and the determination of their height by means of simultaneous observations: Maurice **Farman,** Em. **Touchet,** and H. **Chrétien.** The simultaneous observations were carried out at stations 28·7 kilometres apart, and results were obtained for eighty-three meteors. The average height of the first appearance was 103·6 kilometres (extremes 138·5 and 53·9), of disappearance 75·8 (extremes 131·6 and 33·4), the average length of the trajectory being 35·2 kilometres.—On the singularities of analytical functions: L. **Zoretti.**—An attempt at a determination of the difference of longitude chronometrically: Paul **Ditisheim.** The difference of longitude between Paris and Neuchâtel was determined by carrying with special precautions five chronometers between the two places, the mean result being 18m. 28·86s. It is proposed to check this by a new telegraphic determination.—On the fall of water in rivers: Edmond **Maillet.**—On the melting point of gold and the expansion of some gases between 0° and 1000° C.: Adrien **Jacquerod** and F. Louis **Perrot** (see p. 14).—On the atomic weights of hydrogen and oxygen, and on the probable value of their atomic ratio: Ph.-A. **Guye** and Ed. **Mallet.** The method proposed by Vallier for treating a limited number of observations is applied to the reduction of the observations of E. W. Morley on the atomic weights of hydrogen and oxygen. The final value is $O=15\cdot8787$ for $H=1$.—Experimental researches relating to some cyclic amines: P. **Lemoult.** The heats of combustion of some amines calculated by means of the formula given by the author in a previous paper show in a few cases wide deviations, and it appeared advisable to re-determine experimentally some of these measurements. The results of determinations made with the Berthelot bomb for xylidine, monoethylaniline, *p*-anisidine, α-naphthylamine, and β-naphthylamine are given, and agree with the figures calculated from the formula within 0·5 per cent.—The formation of hydrogen silicide by direct synthesis from its elements: A. **Dufour.** At a very high temperature, hydrogen and silicon unite directly to form hydrogen silicide. The amount formed is small, and the product was identified by its chemical re-

actions and its boiling point (−116° C.).—The lead-aluminium alloys: H. **Pécheux.** Alloys containing 93, 95 and 98 per cent. of aluminium were obtained, the properties of which are described.—On colloidal gold: M. **Hanriot.** Colloidal gold, prepared by the method of Henrich, exhibits properties which are inconsistent with the assumption that it consists merely of finely divided gold.—A new indicator and its application to the detection of boric acid: Lucien **Robin.** The indicator proposed is extracted from mimosa flowers by weak alcohol. Its general behaviour is similar to that of phenol-phthalein, with the advantage that it can be used in the presence of ammonia. It gives a characteristic reaction with borates, and may be used for this purpose in the analysis of food products.—The action of magnesium and organo-magnesium compounds on bromophenetol: V. **Grignard.** Bromophenetol reacts readily with magnesium powder, giving ethylene and $C_6H_5O:MgBr$ instead of the normal compound $C_6H_5OCH_2CH_2MgBr$.—On the lactone of oxy-crotonic acid and the γ-substituted crotonic acids: M. **Lespieau.**—Researches on the dinaphthopyranic series: R. **Fosse.**—Remarks on some peculiarities of the flora of Long Island: Ph. **Eberhardt.** The views of the author given in previous papers on the influence of the amount of atmospheric moisture on the growth and development of plants have received confirmation from a study of the growth of vegetation on Long Island.—Researches on the browning of the vine: L. **Ravaz.** The browning of the vine is a particular case of impoverishment of the plant brought about by production. It may be avoided by the use of manures rich in potash.—On the evolution of the relief of the plateau of Mehedinti, Roumania: E. **de Martonne.**—On the faults and undulations of the secondary and tertiary layers of the Loir: Jules **Welsch.**—On an albumen extracted from the eggs of fishes: the comparative chemistry of the sexual products in the same species: L. **Hugounenq.**—Autolysis of the tissues of the animal organism and the genesis of morbid phenomena: A. **Charrin.**—The colloidal state of metals in mineral waters; natural oxydases and their therapeutic action: F. **Garrigou.**—On a mechanical apparatus allowing of trepanning and vibratory massage: M. **Bercut.**

DIARY OF SOCIETIES.

THURSDAY, MAY 5.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30—Experiments on a Method of Preventing Death from Snake Bite, capable of Common and Easy Practical Application: Sir Lauder Brunton, F.R.S., Sir Joseph Fayrer, Bart., F.R.S., and Dr. L. Rogers.—A Research into the Heat Regulation of the Body by an Investigation of Death Temperatures: Dr. E. M. Corner and Dr. J. E. H. Sawyer.—(1) A Note on the Action of Radium on Micro-organisms; (2) Further Note on Some Additional Points in Connection with Chloroformed Calf Vaccine: Dr. A. B Green.—On Certain Physical and Chemical Properties of Solutions of Chloroform in Water, Saline, Serum and Hæmoglobin. A Contribution to the Chemistry of Anæsthesia—Preliminary Communication: Prof. B. Moore and Dr. H. E. Roaf.

LINNEAN SOCIETY, at 8.—British Freshwater Rhizopoda: J. Cash.—On Coloration in Animals and Birds: J. Lewis Bonhote.—On the Cranial Osteology of the Fishes of the Families Mormyridæ, Notopteridæ and Hyodontidæ: Dr. W. G. Ridewood.

RÖNTGEN SOCIETY, at 8.30.—The Röntgen Society; its Past Work and Future Prospects: J. J. Vezey.—Some Experiments with Alpha Rays: F. H. Glew.

CHEMICAL SOCIETY, at 8.—The Slow Combustion of Ethane: W. A. Bone and W. E. Stockings.—Note on the Hydrolysis of Starch by Diastase: J. S. Ford.—The Reesin Acids of the Coniferæ. Part I. The Constitution of Abietic Acid: T. H. Easterfield and G. Bagley.—The Action of Radium Rays on the Halides of the Alkali Metals, and Analogous Effects produced by Heat: W. Ackroyd.—The Dynamic Isomerism of Glucose and of Galactose. Solubility as a means of Determining the Proportions of Dynamic Isomerides in Equilibrium: T. M. Lowry.—A Study of the Substitution Products of *ar*-Tetrahydro-α-naphthylamine, *ar*-4-Bromotetrahydro-α-naphthylamine and *ar*-Tetrahydro-α-naphthylamine-4-sulphonic acid: G. T. Morgan, Miss F. M. G. Micklethwait, and H. B. Winfield.—The Additive Products of Benzylideneaniline with Methylacetoacetic Ester and Acetoacetic Ester: F. E. Francis and Miss M. Taylor.

INSTITUTION OF MINING AND METALLURGY, at 8.—Discussion on Laboratory Equipment (conclusion).

FRIDAY, MAY 6.

ROYAL INSTITUTION, at 9.—Anthropoid Apes: Dr. P. Chalmers Mitchell.

PHYSICAL SOCIETY, at 8.—An Experiment with Lubricating Oil: W. A. Price.—Some Instruments for the Measurement of Large and Small Alternating Currents: W. Duddell.—Exhibition of Apparatus from the National Physical Laboratories.

MONDAY, MAY 9.

ROYAL INSTITUTION, at 5.—General Monthly Meeting.

FARADAY SOCIETY, at 8.—Studies in Viscosity: Dr. C. E. Fawsitt.—The Electrolytic Oxidation of Anthracine: Alberto Fontana and F. Mollwo Perkin.

SOCIETY OF ARTS, at 4.30.—The Majolica and Glazed Earthenware of Tuscany: Prof. R Langton Douglas.

TUESDAY, MAY 10.

ROYAL INSTITUTION, at 5.—Meteorites: L. Fletcher, F.R.S.

SOCIETY OF ARTS, at 8.—Crystalline Glazes and their Application to the Decoration of Pottery: W. Burton.

WEDNESDAY, MAY 11.

SOCIETY OF ARTS, at 8.—Early Painting in Miniature: R. R. Holmes.

GEOLOGICAL SOCIETY, at 8.—On some Quartzite-Dykes in the Mountain Limestone near Snelston (Derbyshire): H. H. Arnold-Bemrose.—Phenomena bearing upon the Age of the Lake of Geneva: Dr. C. S. DuRiche Preller.

THURSDAY, MAY 12.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—If the discussion on Messrs. Merz and McLellan's paper is concluded at the meeting of May 5, Messrs. Parsons, Stoney and Martin's paper on the Steam Turbine as applied to Electrical Engineering will be read and discussed.

MATHEMATICAL SOCIETY, at 5.30.—Some Mathematical Instruments: C. Cooke (communicated by Major P. A. MacMahon).—On the Evaluation of Certain Definite Integrals by Means of Gamma Functions: A. L. Dixon.—Generalisations of Legendre's Formula

$$KE' - (K - E)K' = \tfrac{1}{2}\pi:$$

A. L. Dixon.—Note on the Integration of Linear Differential Equations: Dr. H. F. Baker.

SOCIETY OF ARTS, at 4.30.—British Grown Tea: A. G. Stanton.

FRIDAY, MAY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—List of Mollusca collected during the Commission of H.M.S. *Waterwitch* in the China Seas, 1900–1903, with Descriptions of New Species: Surgeon K. Hurlstone Jones, R.N., and H. B. Preston.—On a Carboniferous Nautiloid from the Isle of Man: G. C. Crick.—Notes on the Genus Anoma: E. R. Sykes.—New Land Shells from New Zealand: Henry Suter.

CONTENTS.

THURSDAY, MAY 12, 1904.

SANITARY ENGINEERING.

Refuse Disposal and Power Production. By W. Francis Goodrich, A.M.Inst.M.E. Pp. xv+384. (Westminster: Constable and Co., Ltd., 1904.) Price 16*s*. net.

THE destruction of town refuse by fire is a comparatively modern development; the first furnaces erected for such a purpose were constructed to the designs of Mr. Fryer at Manchester in 1876, and these furnaces, though considerably modified, are still at work. The gross insanitary character of the ordinary system of refuse disposal is patent to everyone who has occasion to move about in the neighbourhood of any of our large cities; the refuse is deposited in tips; often an old quarry or gravel pit is selected for this purpose, and the refuse is dumped into these cavities until they are filled up. How unsatisfactory this is has been proved by the fact that outbreaks of disease have occurred directly traceable to the existence of these heaps of abomination. The author states that an outbreak at Fratton was certified by the medical authorities to be due to the contagion brought by flies bred in the pestiferous heaps of Portsmouth refuse which had been deposited in this neighbourhood. These refuse heaps in the summer time breed flies in millions, and they are the constant resort of rats, which spread from them all over the neighbourhood, and how readily most dangerous diseases are disseminated by both these agencies is well known to all medical authorities. We had this fact brought home to us clearly during the late campaign in South Africa, when the nurses and doctors in the field hospitals were frequently able to tell that a patient being brought in was a typhoid sufferer from the swarms of flies round him.

Fortunately the Local Government Board is setting its face steadily against a continuation of this insanitary practice, and the recent example at Bury St. Edmunds, quoted by Mr. Goodrich, where the board refused to sanction a loan for the purpose of purchasing land for a tip, is a striking illustration of this modern tendency. Refuse tipping at sea, owing to the fact that much of the refuse is liable to be washed back on the foreshore, and also that it has frequently to be stored for lengthy periods owing to stormy weather, is an equally unsatisfactory method.

The book is fully illustrated, and two or three of the illustrations, reproduced from photographs, show the filthy state of affairs brought about by town authorities neglecting to avail themselves of modern appliances. The author discusses very fully the various systems of burning refuse in destructors which have been adopted in this country, for it is chiefly in Great Britain that fire purification has been adopted, and the various systems of charging the refuse into the destructor cells are described in detail; the direct charging systems are compared very fairly with the hand or shovel feeding systems.

Though the former, from the sanitary point of view, naturally appears the more desirable, there can be little doubt from the figures given by Mr. Goodrich that there is not much economy in labour by the adoption of direct charging, since the labour of dragging the material from the drying hearth forward on to the grates is greatly increased. The first types, founded on a system of natural draught and low temperatures in the cells, undoubtedly did much to retard the development and the introduction of destructors, and in this connection to Mr. Charles Jones, of Ealing, must be given much credit, because his cremator certainly led the way to the design of the modern forced draught high temperature destructor.

Illustrations and descriptions are given of most of the destructors which have been used up to the present time, and then the author deals exhaustively with the labour cost in the different systems, with the utilisation of the clinker, and with the application of the steam generated to electricity works, sewage works, or waterworks. The figures given for the labour cost show very striking variations in the different towns, ranging from as low as $6\frac{3}{4}$*d.* per ton of refuse burnt to as high as 2*s.* 10*d.*; the higher cost in a few cases arises from the fact that the quantity of refuse to be destroyed is comparatively small, and therefore the three shift, eight hour system, which is the more economical, cannot be adopted.

The disposal of the clinker no longer presents any real difficulty, as in the modern destructor the temperature is easily kept high enough and sufficiently steady to produce a thoroughly hard, well burnt clinker suitable for many purposes. The late Mr. J. McTaggart, of Bradford, did much in directing attention to the various uses to which the clinker could be applied, and the results he obtained were remarkable; clinker bricks, clinker tiles, clinker mortar, clinker concrete were some of the products into which his waste material was converted, and Bradford led the way in showing that by the utilisation of this residuum, which amounts on an average to about one-third of the weight of the total refuse consumed, much of the cost of running a destructor can be repaid. The utilisation of the steam generated has also made great strides during the past few years, and at the present time there are, the author states, sixty combined electricity and destructor works either running or under construction in this country, several of them of considerable size, the electricity generated being used both for lighting and for traction.

The author gives a comparative statement showing the number of electrical units generated per ton of refuse destroyed in twenty of these stations, the figures ranging from as low as 15 to as high as 80 per ton of refuse burnt. He quotes, from reports of station engineers, opinions which show conclusively that whatever difficulties may have been experienced at first, owing to variations in the steam pressure, at the present time it is quite as easy to run a plant satisfactorily with steam produced from the waste heat of the destructor furnaces as when generated in an ordinary boiler using coal or other fuel. About thirty-eight towns are using steam from the destructors for driving pumping plants in connection with sewage dis-

posal works, and the town of Sheerness has taken a still bolder departure in the application of such steam to work pumps supplying the town with water. This latter scheme was carried out by the author himself, and he is thus able to give full details as to the economical results of this installation; the first six months' working showed a saving of nearly 500*l.*, equal to a reduction of 3*d.* per 1*l.* in the town rates. The comparative advantages of steam jet blowers and fans are contrasted, and Mr. Goodrich clearly leans towards the former as the more economical in the long run; in this connection he lays great stress upon the absolute necessity of systematic tests of the waste gases in order to determine whether or not combustion is going on under the most economical conditions; a diagram given on p. 157 shows how serious the heat losses may be if excess air is used.

The second half of the book is devoted to a description of all the refuse destructors which have been put to work in Great Britain and abroad up to the present time. The date of the installation, the type and make of destructor, the number of cells, the number and type of boilers, height of chimney, the type of draught used, the purpose for which the power is used, the weight of the refuse destroyed daily, and the labour cost per ton of refuse destroyed are all given. Most complete information in regard to this important subject has thus been brought together, and there can be no doubt that it will prove a most useful reference volume to those engaged in planning such plants, and to municipal authorities who are considering the desirability of erecting destructors. Up to the present the various details and results given by Mr. Goodrich have been scattered through the *Proceedings* of one or two of our engineering societies, or embodied in the reports of borough engineers, and it can have been no light task to gather together the mass of information in this book. We have no hesitation in saying that it will be a standard book of reference for several years to come, and it is in a form in which it will be comparatively easy, in the re-issue of fresh editions from time to time, to keep it up to date.

T. H. B.

GEMS AND PRECIOUS STONES.

Precious Stones, a Popular Account of their Characters, Occurrence and Applications, with an Introduction to their Determination, for Mineralogists, Lapidaries, Jewellers, &c., with an Appendix on Pearls and Coral. By Prof. Max Bauer. Translated from the German, with additions by L. J. Spencer. Pp. 627; with 20 plates and 94 figures in the text. (London: Charles Griffin and Co., Ltd., 1904.) Price 42*s.* net.

Gems and Gem Minerals. By Dr. Oliver Cummings Farrington. Pp. 229; with 16 coloured plates and 60 half-tone and line engravings. (Chicago: A. W. Mumford, 1903.)

THE publication in 1890 by the Scientific Publishing Company of New York of Dr. G. F. Kunz's valuable "Gems and Precious Stones of North America" showed for the first time the possibility of producing, by modern methods of photolithography, illustrations of gems, either cut or uncut, which would give some idea of their characteristic colour, transparency and lustre. The two works of which the titles appear above have adopted the same methods of illustration, and the plates are scarcely inferior in beauty and in fidelity to the originals to those which adorn Dr. Kunz's well known book.

Prof. Max Bauer's "Edelsteinkunde" was issued in parts in 1895 and 1896, and at once took a foremost place in scientific literature as the standard work on all subjects relating to gems. It deals not only with the methods adopted by mineralogists and others for determining the mineral species to which gem stones must be referred, but with such questions as their artificial production, counterfeiting of gems, and their alteration by heating, &c.—questions upon which it is often very difficult to obtain satisfactory and trustworthy information. While mainly devoted to gems viewed from the scientific standpoint, much valuable information is added on the cutting, mounting and price of gems, while the accounts of the localities and mode of their occurrence are exceptionally full and complete, the descriptions being illustrated by sketch-maps and plans of workings. The coloured plates give some idea of the brilliancy and exquisite beauty of the original objects, whether these be crystals in their matrix or cut stones. They are scarcely, if at all, inferior in these respects to those in the work of Dr. Kunz already referred to, and higher praise than this can scarcely be given.

Mr. Spencer has been well advised in undertaking the translation, with the aid of his wife, of this important standard work. But the book as it now appears in English dress is much more than a mere translation. Mr. Spencer's familiarity with the bibliography of mineralogy is well known, and he brings to his task, in addition, wide knowledge and experience gained in connection with his work in the splendid national collection of minerals at South Kensington. The author of the work has supplied references to the more important papers which have been issued since the first appearance of the book, and these with many other works, including the valuable annual reports on the production of gem stones by the United States Geological Survey, have been consulted by the translator, many new and valuable facts being added. It would be easy to show, however, that even during the decade that has not quite elapsed since the book was written, much new information has accumulated on many of the subjects dealt with, and to incorporate this, as the translator points out in the case of the diamond, so as to bring the matter quite up to date, would involve the complete re-writing of whole sections. The work is, nevertheless, so complete, trustworthy and up to date that no better guide to the study of gems can be indicated to the student, the worker, or the dealer in these interesting objects.

The general account of precious stones occupies 110 pages, and, as the translator admits, would have to be considerably enlarged if full justice were done to the optical methods of discriminating the mineral species. This, however, would have only a limited

interest for general readers, and therefore is perhaps wisely omitted.

The account of the diamond takes up no less than 150 pages, and, large as is the amount of information collected, there is much more that might with advantage have been included if all the researches of recent years could have been utilised. As it is, the book brings together an enormous mass of details which could only be obtained by long and patient research among widely scattered sources of information. The corundum and beryl gems, topaz, opal, &c., are also very fully treated; but an important feature of this work is the account given of the large number of crystalline minerals, quite unknown to lapidaries and the general public, which are capable of being employed as gems, and as such, are scarcely, if at all, inferior in beauty to the stones which have become famous and are so universally sought after. The varieties of zircon, spinel and tourmaline, which, in the hands of a good lapidary, are capable of yielding gems of exquisite colour and beauty, are well described in this work; while the numerous minerals which more rarely yield transparent and lustrous varieties that can be cut as gems are indicated by the author. In this connection we may point out that even the rare and beautiful varieties of spodumene—known as hiddenite and kunzite—have been included in this edition. The appendix on pearls and coral is interesting, and is necessary to complete the book as a work of reference on the subject. We heartily congratulate the author on having found so competent and judicious a translator, and the translator on having devoted his attention to a work so well worthy of having labour spent upon it

Dr. Farrington's book is on a much smaller scale than Prof. Max Bauer's, but the illustrations are of the same beautiful character. The general account of precious stones has to be compressed into 65 pages, but, as might be expected from the author, the matter is accurate and is very judiciously arranged, while some of the discussions, like those on the superstitions connected with precious stones, are full of interest. The account of the several minerals—not only those so commonly employed as gems, but the rarer ones which can be cut and used in the same way—is, as in the case of Max Bauer's treatise, very full and accurate; but the treatment of each has, from the scope of the work, to be much more concise. The typography and general appearance of the book are of the excellence we are in the habit of finding in the best publications of the American Press J. W. J.

SPECIALISED CHEMISTRY.

Synthetische Methoden der organischen Chemie. By Theodor Posner. Pp. xxxi + 435. (Leipzig: Veit and Co., 1903.)

CHEMICAL literature has assumed such enormous proportions during the last two decades that it is at times almost like seeking a needle in a haystack to endeavour to find whether certain branches of the subject have previously been worked at or not. The difficulty is not so much on account of the variety of books written on the different branches of chemistry, although their number is colossal, but because there are so many journals and periodicals, and because these are so widely distributed.

A chemist who studies or works along a special branch of the subject might hope that all others who work on similar lines would endeavour to publish their results in one or other of a limited number of journals. Actually this is not the case, and as a consequence he must either take in an immense number of periodicals, most of which time will not permit him to glance at, much less study, or he must join some society which takes in these journals. There is, of course, another and very real objection to taking in a vast number of journals—the expense. Those who devote themselves to scientific research are not—generally speaking—endowed with excessive riches. Chemists, therefore, are ready to welcome works which are accurate compilations of scientific research, but even here, *vanitas vanitatis*, the books are out of date almost before they have left the press. However, they are good and useful up to the time at which they were published, and may save a good deal of back reference.

The book before us is such a compilation. When one is engaged on research it is of the greatest possible advantage to be able to consult a work which will tell us at a glance all the most important methods for carrying out this or that operation.

For example, a chemist may be dealing with a substance which he suspects may be a ketone. He is aware that ketones form oximes, hydrazones, semicarbazides, &c., but he may not have at his fingers' ends all the methods which can be employed to bring about these reactions. Dr. Posner's book will be of great help to him in such circumstances.

The book commences with a florid introduction, from which we gather the author's object in writing the book. It is briefly to give a collection of synthetical methods which are of general applicability. Special syntheses for particular compounds are not given, even when they are of great individual importance. In only giving general reactions we think the author was well advised, otherwise the book must have assumed unwieldy proportions.

Under the heading of sulpho-acids we find various methods for sulphonating the hydrocarbons, chloro-compounds, amido-compounds, &c. Dr. Posner rarely condescends to give exact methods of preparation, this, we presume, because very full references are appended at the bottom of each page. This is all very well where one has a large library which contains the books and journals from which the references are taken, but it rather detracts from the value of the work. The great advantage of such a work as this should be its enabling one to dispense with a large number of reference books.

The book is divided into four main parts. The first part deals with the hydrocarbons, and commences with a short description of the different classes of hydrocarbons in the aliphatic series. We then come to a short description of some of the methods of preparation of acetylene and diacetylene. This leads us up to ring hydrocarbons and ring syntheses. Part ii. treats of

the single derivatives of the hydrocarbons, such as the halogen, nitro, amido, &c. The third part is devoted to the study of the poly-compounds. The sugars are here dealt with, and are very fully given. On p. 265 there is a very useful diagram showing schematically the sugar syntheses. The fourth part treats of heterocyclic compounds.

The theoretical introductions at the commencement of the subsections are succinct, and give one an idea of the particular class of substance in a few sentences. A little more space might have been given to the quinones. Under this heading we only find one and a half pages, most of which is devoted to benzoquinone. There are, indeed, other references to quinones in the book, but these do not deal with the modes of preparation.

The compilation of a book such as this requires an immense amount of work, and we think, taking it as a whole, although there are a good many omissions, that Dr. Posner is to be congratulated on having brought out a really useful work. F. M. P.

CHEESE-MITES.

British Tyroglyphidae. By Albert D. Michael, F.L.S., F.Z.S., F.R.M.S., &c. Vol. ii. (London: Printed for the Ray Society, 1903.)

THIS is a second volume only by date and binding; otherwise it is part and parcel of the first, completing the story with all the scientific skill in description and illustration, the critical acumen, and the due proportion of enlivening touches to which attention was directed in these columns two years ago. An annotated list of the principal known or supposed species, not hitherto recorded as British, is a valuable supplement, here thrown in as a free gift beyond the requirements of the title. An interesting addition to the group of cheese-mites is furnished by the new genus and species, *Fusacarus laminipes*, a little fusiform broad-legged acarid discovered by Mr. Michael in moles' nests, sometimes abundant, yet not present in every nest, and never observed upon the mole itself.

Among statements of economic importance may be noted the author's remarks on *Tyroglyphus longior*, Gervais. Of this he says:

"It seems to me to be found in almost all houses upon dried provisions, often swarming in enormous numbers. I have also found it most prolific on hay and fodder, often increasing in countless millions. I once had a sample of hay sent me from a large haystack on a first-class farm in Ireland; the whole stack had practically been destroyed by this Acarus; there were, weight for weight, as large quantities of Acari as of hay in the sample."

On the other hand he vindicates *Histiogaster entomophagus* (Laboulbène) from the reproach, conveyed in its specific name, of devastating entomological collections. Also he agrees with the French acarologists in being hard of belief that the mite which Riley and Planchon called *Tyroglyphus phylloxerae* was at all likely to benefit the French vine-growers by its importation. For one thing, in his opinion, France already possessed the mite in question under an earlier name, and for another, he holds that cheese-mites in general are not at all partial to feeding on insects until the insects are not only dead, but dried, in which condition the dreaded Phylloxera ceases to be a devastator of vineyards. But if Riley's mite does the wine-producer no essential good, *Carpoglyphus anonymus*, Haller, does the wine-vendor positive harm. Anything, indeed, might be expected of a creature so reprobate that it devours the gold size of the very cell in which it is being reared for scientific observation. But this species, which in very Irish fashion has been named "the nameless," further outrages sentiment by being, what the lower animals so seldom are, a set of little drunkards. They defy the great wine-merchants of Paris by increasing in immense quantities inside the wine bottles, "maintaining their position on the surface of the wine without getting drowned by standing on minute pieces of cork," and in this ideal home for inebriates drawing their nourishment from the wine.

Directly in his preface and incidentally elsewhere Mr. Michael directs attention to the unsatisfactory process by which chains are being riveted on zoologists in regard to nomenclature. His remarks are opportune. It may easily come to be supposed that the important compilation of "Das Tierreich" represents on this and some other questions a consensus of opinion. But that is contrary to the fact, the apparent consensus meaning nothing more than a (possibly very reluctant) concession to a supposed need for uniformity, by which the value of "Das Tierreich" itself is not a little likely to be seriously impaired. Moreover, the rules which appear to have been agreed on by the committee of the International Zoological Congress are themselves under more than one grave disadvantage. The report brought up to the highly representative meeting of that congress at Cambridge in 1898 was for some esoteric reason withdrawn from discussion. This opportunity being lost, a larger committee was appointed, but the rules appear to have been settled by only five of the members, Great Britain being left unrepresented at the critical time, through the withdrawal of two members and the absence of a third. After all, perhaps, it is consoling to reflect that rules can only find their ultimate sanction in the practice of the best writers, and work like Mr. Michael's helps one to maintain that British zoology is neither dead nor sleeping, and that it cannot in the long run be left out of account.

OUR BOOK SHELF.

Zoology: Descriptive and Practical. By Prof. Buel P. Colton. Part i. Descriptive. Pp. x+375; 201 figures. Price 4*s.* 6*d.* Part ii. Practical. Pp. xvii+204. Price 2*s.* (London: D. C. Heath and Co., 1904.)

THE author points out in an admirable preface that the study of natural history in schools should follow the seasons, and that animals should be studied in relation to their surroundings. "The study of the relations of animals to their surroundings is a constant investigation of cause," and the pupil has above all to inquire into the meanings of facts. But exercises in classification, in the detailed analysis of types, in

definition making, and so on, are also, he maintains, of great value. The book has been read critically by numerous teachers—some of whom are well known experts—so that it ought to be well-nigh faultless within its limits. The descriptive part begins with insects, leaving difficult groups like Protozoa and Cœlentera to near the end; it is elementary in its mode of treatment, with refreshing breaths of the open air, admirably free from technicalities, and always clear. But the author has tried far too much, and his terseness is repeatedly gained at the expense of accuracy. We do not see the object of attempting a complete survey in a book like this, of dragging in sirenians and brachiopods—the whole show, in short—when the exigencies of space appear to have made it impossible to say about many classes anything worth reading. If the author had been less ambitious of completeness, his book would have been more useful. The practical part of the book, which includes a large variety of material, and mostly consists of simple directions and suggestive questions, is in our opinion a much stronger piece of work. The studies on insects, the crayfish, the earthworm, the turtle, the snake, the rabbit, and many more, considered both as intact living creatures and as objects for anatomical analysis, are admirably conceived and well worked out. The Socratic method is adhered to throughout, and the practical volume will be found very valuable both by teachers and students. It presupposes for the natural history lessons more time and more freedom than is usually allowed in Britain. It should also be noted that there are terse directions on several topics which are rarely alluded to in books on practical zoology, such as skinning birds and mounting insects. Our general impression is that Prof. Colton, who is evidently a skilful teacher, should have expanded and illustrated the *practical* part of his book, incorporating in it all that is personal and distinctive in the *descriptive* part.

J. A. T.

Among the Garden People. By Clara D. Pierson. Pp. viii+236; illustrated. (London: John Murray, 1904.) Price 5*s.*

Our American friends, if not actually ahead, are well up to our level in the matter of encouraging and protecting the native birds of gardens and plantations, and the author has therefore been well advised in arranging for an English edition of the work before us. She has been equally well advised in changing the original title of "Dooryard Stories" for the one this dainty little volume now bears, for few amongst us, we think, are aware that "dooryard" is American for "garden." The American title is, however, still retained in the page-headings.

The book is essentially one for juvenile readers, being written in the form of simply worded stories, in which the birds are made, so far as possible, to tell their own tale according to what may be supposed to be their own ideas. Despite a certain amount of confusion which is almost sure to arise from the misappropriation of the names of familiar English birds for totally different American species, it is certainly an important element in the natural history education of young people that they should be made to understand that the birds of distant lands differ markedly from those of their own, and, as the author observes, it may be a decided advantage to those who visit in mature years the New World to have already made some amount of acquaintance with its feathered denizens.

Not that this volume is by any means absolutely restricted to the birds of American gardens, for it tells us a good deal about some of their four-legged enemies, such as red squirrels and chipmunks. Some of the American names, such as the latter, are explained in a short glossary, in which we are somewhat amused to find the raccoon described as "an American animal, allied to the bear family, but much smaller, and much hunted both for its flesh and its fur." Surely something a little more exact and more to the point could have been supplied by the author's naturalist friends.

The numerous "three-colour" plates are for the most part good and artistic representations of the species they portray, and the volume may be recommended as an attractive gift-book for young people.

R. L.

New Physical Geography. By Ralph S. Tarr, B.S., Professor of Dynamic Geology and Physical Geography at Cornell University. Pp. xvi+457. (New York: The Macmillan Company, 1904.) Price 1 dollar.

As Prof. Tarr says in his preface, the teaching of physical geography is still in its experimental stage. The publication of this volume, which is the third on the same subject by the same author, who now "does not flatter himself that he has produced the ideal," shows there is work yet to be done by teachers of geography. But whether this volume is ideal or not, it is certainly an excellent text-book of the subject. Prof. Tarr begins with a short and not altogether satisfactory chapter on the earth as a planet, and proceeds to a treatment of the lands of the globe. These chapters are followed by descriptions of atmospheric and oceanic phenomena, which are less extended than in the author's previous books, and by an account of the physiography of the United States. The volume concludes with chapters treating of life in its relation to the land, air, and ocean—the last one being called "Man and Nature." Several subjects usually included in books on physical geography are relegated to appendices, and among these may be mentioned: revolution of the earth, latitude and longitude, tides, magnetism, and meteorological instruments. There are 568 illustrations, most of which are of a striking and instructive character.

Quiet Hours with Nature. By Mrs. Brightwen. Illustrated by Theo. Carreras. Pp. xvi+271. (London: T. Fisher Unwin, 1904.) Price 5*s.*

Mrs. Brightwen writes in a way that is sure to gain the attention of young people. Her sketches are in no sense formal scientific descriptions of the familiar animal and plant life of this country, but they are likely to arouse an interest in natural history and to lead readers to observe for themselves. The book shows clearly how much worth close inspection and study an English garden contains, and rightly indicates there are common phenomena which still remain unexplained. The book is well illustrated and deserves to be a favourite with boys and girls.

Le Monde des Fourmis. By Henri Coupin, Lauréat de l'Institut, &c. Pp. 160. (Paris: Delagrave.)

This is a small popular book relating to the habits, architecture, and intelligence of ants, and largely consists of extracts from the works of Huber, Forel, Lubbock, Moggridge, and other well known writers, chiefly French and English. The subject of the book cannot fail to interest those previously unacquainted with it, but it contains little that will not be familiar to everyone who has read any recent works on ants. It is very inferior to such a book as Ernest André's "Les Fourmis," published in 1885, but we believe that this has been out of print for some time. We may add that M. Coupin's book contains a few illustrations of a very inferior description.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Life-history of Radium.

IN a letter under the above title in NATURE of May 5, Mr. Whetham brings forward some results dealing with the hypothesis that radium is being produced from uranium. May I be permitted to state that I have been engaged during the last twelve months in an experimental examination of this hypothesis? In the paper in which the suggestion was made that radium may be being formed by the disintegration of a parent element possessing heavier atomic weight (Rutherford and Soddy, *Phil. Mag.*, May, 1903, p. 587), this sentence occurs:—"The point is under experimental investigation by one of us, and a fuller discussion is reserved until later." Mr. Whetham's letter makes it desirable that the results that have been obtained during the past year should be published.

Twelve months ago I purified a kilogram of uranium nitrate until the quantity of radium present was less than 10^{-13} gram. This was the limit of detection by means of the electroscope employed, using the maximum or equilibrium amount of accumulated radium emanation as the test for the presence of radium. It was arrived at by direct comparisons with the emanation from a standard milligram of radium bromide, by subdivision until its presence could no longer be detected. Unfortunately, owing to the large amount of radium in the laboratory, subsequently introduced for the purpose of the helium research, the electroscopes have been affected, and it is not possible at the present time to be sure of such minute effects as originally. But it may be stated that less than 10^{-11} gram of radium has accumulated in the kilogram of uranium during the past twelve months. This practically settles the question so far as the production of radium *from uranium* is concerned.

In a paper read recently before the Royal Society by Sir William Ramsay and myself, an experimental determination of the rate of change of radium was given. It was shown that rather less than one-thousandth part changes per year. The rate of change of uranium may be taken as a million times slower, since its radio-activity is a million times less; so that, in one kilogram of uranium nitrate, about 5×10^{-7} gram would change per year. The quantity of radium produced was less than 10^{-11} gram, so that the conclusion is arrived at that if uranium changes into radium, less than one-ten thousandth part of the theoretical quantity is produced during the first year's accumulation.

The result, of course, may be explained by assuming the existence of intermediate forms between uranium and radium. But from a general consideration of the whole question from the point of view of the disintegration theory, several such hypothetical forms, each with an extended life, must be assumed. So that unless modifications are made in the theory, which at present are not justifiable, the evidence may be taken as indicating that uranium is not the parent element of radium. The experiments will be continued from year to year with the kilogram of uranium nitrate. But as I am leaving England immediately, and shall be away several months, I take the opportunity of presenting the results of the unfinished research, and hope at a later date to give a fuller account.

FREDK. SODDY.

University College, Gower Street, W.C.

IN their communication to the Royal Society of April 28, Sir William Ramsay and Mr. Soddy by direct measurements determine the rate of decay of radium as one thousandth of the mass per annum, giving as the average life of the radium atom about one thousand years.

This rapid rate of decay, of course, renders it quite out of the question to assume that in the radium now existing on the earth we are dealing with the residue of a larger quantity reduced by decay to its present amount. If we carry backwards so great a rate of change we, in fact, arrive at the existence of such large amounts quite a few thousand years ago as to postulate a red hot earth almost within historical times. We are thus either compelled to assume that the rate of transformation observed does not apply generally to terrestrial radium, but only to radium separated by chemical treatment from pitchblende, or that the existing store of radium is derived by steady supply from some substance of greater atomic weight. The first hypothesis, in view of what is known as to the intimately atomic nature of radio-activity, may be dismissed.

That the probable source of radium is uranium is advocated by Prof. Rutherford in his book on radio-activity. From a conversation with Sir Oliver Lodge I gather that he also considers this not improbable. The reasons for it need not be given here.

Now if radium is derived from pitchblende, the rate of change of radium is a measure of the rate of change of pitchblende, supposing a steady state of supply and loss has been attained. This last condition I think we are entitled to assume, although doubtless from the mathematician's point of view a perfect equality would be improbable. But I will quote Prof. Rutherford ("Radio-activity," p. 334):—"Since radium has a short life compared with that of uranium the amount of radium produced should reach a maximum after a few thousand years when the rate of production of fresh radium—which is also a measure of the rate of change of uranium—balances the rate of change of that product."

Let us now assume as an approximation that from 1000 kilos. of uranium the yield of radium under the most favourable conditions would be one decigram. It may here be observed that the fact of pitchblendes varying in their content of radium is only what is to be expected under the conditions of preservation of the ore, exposed as it is to chemical attack, or, as Prof. Rutherford points out, to the action of percolating water. We have in seeking to learn the content of radium for our present purpose to take the maximum observed.

The one decigram of radium transforms into substances of lesser atomic weight at the rate of one-tenth milligram per annum. Now this is also the annual supply from 1000 kilos. of uranium. In other words, the uranium breaks down at the rate of $1/10^{10}$ part of its mass per annum. The average life of the uranium atom is according to this ten thousand million years.

In determining this average life from so short a period of observation we, of course, make the assumption that the death rate observed is an average one, and that a steady state is attained truly founded on the mean longevity of a vast number of individuals of varying ages, varying rates of loss of corpuscular temperature as well as of varying amounts of initial corpuscular energy, such conditions as would attend material evolution according to Prof. J. J. Thomson's fascinating book "Electricity and Matter." Similar assumptions must be made before we could deduce the average longevity of a vast population from a short period of observation of the death-rate.

On these assumptions an interval of time is indicated which may be considered a minor limit to the antiquity of matter in our part of the universe. For if the average life is really 10^{10} years, must we not assume that some of the atoms now expiring as uranium were existing ten thousand million years ago? Geological time, as we guess it, is but little more than a moment in the being of so great an era—as thirty-six seconds is to an hour.

Whether we will ever be able to obtain direct *proof* of so remote an antiquity is impossible now to say, but it is remarkable that the rate of change of thorium to thorium X affords the same average longevity for the atom of thorium as we arrive at on the data above for uranium, or again from the known rate of change of uranium to uranium X. Thus Rutherford gives 10^{-16} to 10^{-17} as the change-rate per second to thorium X. The change-rate 10^{-10} for a year's disintegration will be found to lie between these limits.

J. JOLY.

Trinity College, Dublin, May 1.

Behaviour of Radium Bromide Heated to High Temperatures on Platinum.

IT may be of interest to record that radium bromide obtained from Schuchardt, of Görlitz, and stated to be pure, melts at 728° C. This number is arrived at by observations on minute specks of the substance heated upon the platinum ribbon of the meldometer.

At higher temperatures—up to 1600°—there is every appearance of decomposition, a quiescent glass finally remaining on the hot platinum. After the experiment it is found that the platinum is deeply pitted, and that in some of the pits the limpid glassy substance remains imbedded. This glass is insoluble in hot or cold water or in HCl even after prolonged immersion in the hot acid. It can be removed only partially from the platinum by scraping. Its refractive index is low.

The pitting would most readily be accounted for by supposing a platinum bromide formed, but what, then, becomes of the radium? Is an alloy formed? The ribbon is found to be still radio-active after the experiment, but feebly so. I have not made quantitative observations for possible recovery of activity.

J. JOLY.

Trinity College, Dublin, May 7.

Electromotive Force between Two Phases of the Same Metal.

FROM the microscopic study of the changes which take place in metals in hardening and annealing, I had been led to the conclusion that metals may occur in two phases, a hard or amorphous phase and a plastic or crystalline phase (*Proc.* Roy. Soc., vol. lxxii. pp. 218, 232). In seeking for independent evidence of this, it occurred to me to try if there existed a measurable electromotive force between the two phases, and I have now obtained definite proofs that this is the case in all the metals which have been tested. In the case of silver, a thermo-junction consisting of a hardened and an annealed wire gave an E.M.F. of 128 micro-volts at a temperature of 250° C. This temperature appears to be near the transition point, and beyond this the E.M.F. falls to zero, as the wires are then both in the same phase. Further experiments on the subject are in progress, and the results will be published in due course.

GEORGE BEILBY.

11 University Gardens, Glasgow, May 7.

A Simple Method of Showing Vortex Motion.

IF a little aqueous fluorescein be placed in a glass tube drawn out to a capillary bore, and supported vertically over a tall cylinder of water, so that the orifice is just beneath the surface, the fluorescein will descend through the water in a fine stream.

If the water be quite tranquil and free from any rotatory motion, this stream will continue straight, unbroken, and clearly defined to the bottom of the jar.

Let a tap be given to the stand supporting the tube; a slight swelling will appear on the issuing stream and gradually increase in size, widening as it goes, while the part immediately behind it becomes more and more slender, and finally parts altogether.

The separated portion continues to widen, and the velocity of the centre being greater than that of the edge, it acquires a motion of rotation, and becomes a perfect vortex ring. If a succession of taps be given to the stand, a series of such rings are formed in regular order. As their velocities diminish, their cross sections increase; they alternately pass through one another, and their motion can be observed with great ease on account of the slowness with which it takes place. I do not know if this method of producing vortices is new or not, but at all events it possesses the merit of simplicity.

F. E. BELAS.

Royal College of Science, Dublin, May 3.

Napier's Logarithms.

STUDENTS interested in this subject may be recommended to consult "The Construction of the Wonderful Canon of Logarithms," by John Napier, Baron of Merchiston; translated from Latin into English, with notes and a catalogue of the various editions of Napier's works, by William Rae Macdonald, F.F.A. (William Blackwood and Sons, Edinburgh and London, 1889.)

G. B. M.

THE EXCAVATOR'S VADE MECUM.[1]

IF any man living is qualified to write a book on the subject of excavating it is Prof. Petrie, than whom no one has had a longer and wider experience or more consistent success. And, as a perusal of these pages will show, the work of excavation is something more than the mere overturning of earth with the spade and extraction of such treasures as may be concealed beneath it. There is not only the organisation and direction of labour, with all the knowledge of human—and especially of the Oriental—nature that it involves, the adaptation to physical conditions, the comprehension of the history and geography of the country, and, last but not least, the unerring eye for the disposition of cemeteries or temple sites which is almost an instinct rather than a matter of experience. The ideal excavator must, in addition, be a skilful draughtsman and photographer; he must have some knowledge of chemistry, geology, mechanics, and surveying, besides—*cela va sans dire*—the archæological knowledge which enables him to identify, estimate, and classify on the spot the results of his researches.

That the writer of this book fulfils perfectly in his own person all these requirements, he would probably be the first to deny; but his long experience has given him a title to speak, as it were, *ex cathedra* on all such subjects, and though the work deals almost exclusively with excavation from an Egyptian point of view, it will henceforth be indispensable for its practical value to all investigators in any part of the world. In fact, it contains so much practical advice on every possible head that one may fancy the would-be follower of Prof. Petrie somewhat staggered at the task set before him. The apparatus laid down as essential for preservation and packing of objects alone would seem to necessitate the transport of a whole Whiteley's or Gamage's to the Egyptian deserts. We have been sufficiently curious to compile a list of materials named in these two chapters. They include barrels, zinc trays, brushes of various kinds, paraffin wax, tapioca water, emery paper, gelatine, benzol, silicate solution, glycerine, nitric acid, fuller's earth, sheets of glass, plaster, ammonia, hydrochloric acid and other chemicals, in addition to tools and other more obvious necessities. But perhaps the author regarded this list as a counsel of perfection, as he gives a much shorter one on pp. 112–113.

Seriously, however, all such hints are extremely valuable, and provide for every contingency and every difficulty that may arise in the course of an excavation. The only valid objection that might be taken to them is that much of what is said is perfectly obvious to a person of average intelligence, and that plenty of good work on these lines has been done elsewhere besides in Egypt. However, Prof. Petrie takes his subject seriously and with genuine enthusiasm, and his system affords a welcome contrast to that of the excavator for mere pleasure or for unblushingly commercial ends, to whom archæological results are nothing, and whose labours therefore confer no benefit on any save himself. If we may venture on a word of criticism in general, we may say that he is inclined to be somewhat too severe on the work done by museums and by the stay-at-home archæologist. The explorer, as Mr. Hogarth well pointed out in his charming "Wandering Scholar," can never supply the place of the scholar; happy is he who combines both capacities in his own person, as it has been given to few to do; but the one will always be complementary to the other. Hence we think Prof. Petrie too much inclined to regard excavation (even with all its con-

[1] "Methods and Aims in Archæology." By W. M. Flinders Petrie. Pp. xviii+208; with 66 illustrations. (London: Macmillan and Co., Ltd. New York: The Macmillan Co., 1904.) Price 6s.

comitant labours) as in itself comprising archæology. This cannot be; the excavator supplies the materials, and it rests with him to supply them in a scientific and workmanlike manner; but the years of study which they often demand must be the lot of the student, who, we can assure our author, would often be only too grateful if he had the chance of combining both functions.

The subject is distributed over fourteen chapters, beginning with the qualifications of the excavator himself, the experience or instinct necessary for identifying sites or finds, and three chapters dealing with the actual work in the field—the labourers, methods of turning and raising earth, and recording on the spot. Then follow successive chapters on copying and drawing, photography, preservation of objects, packing, and finally publication. The last four are of a more general nature, dealing with the systematising of results, the nature of archæological evidence, the ethics of archæology, such as the rights of the State, and lastly, the fascination of history by way of epilogue. Space forbids a detailed description of the many interesting points and valuable suggestions contained in these chapters, but the book will be found eminently readable even by those who cannot hope to wield the spade.


FIG. 1.—The clearing of the Osireion at Abydcs, Egypt.

We cannot, however, lay it down without a feeling that the author is throughout too prone to disregard the work of other archæologists; for instance, on p. 123, where he complains that no one since Montfaucon (whose work, by the bye, is singularly useless) has attempted the collecting of series of objects in a *corpus*. Has he never heard of M. Reinach's invaluable *répertoires* of Greek sculpture and vases? Is he not aware that the German Archæological Institute is issuing a magnificent publication of Greek terracottas? And is not a *corpus* of coins under consideration? We purposely pass over the growing number of museum catalogues of all kinds, which if not *corpora*, are still a step in that direction.

The book is illustrated by sixty-six photographic or outline reproductions, of sites, operations, and monuments, the titles of which are at times somewhat oddly arranged (*e.g.* Figs. 36–37), but they are clear, well chosen, and instructive. We have selected for reproduction the frontispiece, representing the clearing of the Osireion at Abydos by a chain of boys with baskets, extending more than forty feet down. The index errs if anything on the side of redundancy; such headings as "carefulness, means of securing"; "chain of boys"; "choice of facts"; "finest lines in drawing"; "list of plates"; "red paint"; "wet squeezes," are not only superfluous, but contrary to all the rules of good indexing. H. B. W.

PROF. A. W. WILLIAMSON, F.R.S.

ON Friday last, May 6, there passed away, full of years and of honour, Alexander William Williamson, one of the most notable of British chemists, and one who, in the heyday of his intellectual activity, exercised a remarkable influence on the development of chemical theory. He had been in failing health for some years past, and such was the seclusion in which he lived of late that his tall manly form and striking features were practically unknown to the younger generation of chemical workers. Indeed, after his retirement, in 1889, from the position of Foreign Secretary of the Royal Society, which he held for some sixteen years, and after the termination of his active connection with the British Association for the Advancement of Science, of which he was treasurer for many years, he rarely visited London, and unless on an occasion when it was represented to him that his influence and the weight of his authority were needed in support of some reform, it was difficult to induce him to revisit the scenes of scientific activity in which he had himself played so strenuous and so eminent a part. Until within the last few years, when his mental powers were obviously failing, he continued to take a keen interest in the progress of science, and it was easy to engage his attention on the broad general lines of its development.

Williamson's mind was cast in a large mould, and, although at times he could occupy himself with even small details if he recognised that these were significant or possibly fruitful of theoretical consequence, he was apt to be impatient of the somewhat tiresome minutiæ with which modern chemical literature abounds. He was probably never a great reader of such literature at any period of his career, and his

physical infirmity made it increasingly difficult for him to keep himself informed. At the same time the very limitation of his physical powers, his partial paralysis, and his poor eyesight, probably conduced to his eminence as a speculative thinker. He was gifted with a strong logical mind, and was an acute reasoner, and a clear, vigorous, and independent thinker, capable of broad and striking generalisation. Knowledge, we know, dwells in heads replete with thoughts of other men, wisdom in minds attentive to their own. Except by personal contact, Williamson was largely debarred from the knowledge of other men's thoughts; by the very circumstances to which allusion has been made he became more attentive to his own. Like most original thinkers he was somewhat tenacious of opinions, and apt to be dogmatic in their utterance. His beliefs were too hardly won to be lightly discarded. But although at times impatient of contradiction, he had too strong a regard for truth, was too sincere and broad-minded a man to persist in any opinion, if its unreasonableness was made clear to him. Like Carlyle, his philosophy was largely swayed by his emotions, and like Carlyle's, his judgments on men and things were apt to be tinctured by the mood of the moment—a fact which may serve to account for seeming inconsistencies in their expression.

He had a high sense of duty, and of the responsibilities of his position as a representative man of science. Although, like many strong men, fond of power, he was in no sense a self-seeking man, and was contemptuous of the artifices by which smaller and more ambitious men seek to gain preferment.

Williamson was born at Wandsworth on May 1, 1824; hence he had just completed his eightieth year at the time of his death. Much of his early life was spent on the Continent. He began the study of chemistry under Gmelin at Heidelberg, in the old cloisters which formerly did duty as class rooms and laboratory, but soon joined Liebig at Giessen. Whilst at Giessen he published, so far back as 1845, his first paper on "The Decomposition of Oxides and Salts by Chlorine," in which he determined the conditions of production of hypochlorous and chloric acids, and the cause of the difference in the mode of action of chlorine upon alkalis and alkaline earths, and upon salts. The main outcome of this paper has long since been worked into the text-books. It is of interest as throwing light upon the theory of the action of bleaching solutions. The experimental material for a short paper on "Ozone" was likewise accumulated at Giessen. In this paper, which also appeared in 1845, Williamson concluded that the peculiar properties belonging to the oxygen set free by the agency of the electric current are produced by the admixture of a *peroxide or acid of hydrogen*, whereas by the action of phosphorus on atmospheric air the same substance is *not* produced. His surmise that a compound of hydrogen and oxygen existed possessing some of the characteristic properties of ozone but dissimilar from Thénard's hydrogen peroxide has not been established by subsequent investigation.

At about this time Williamson took his degree, and in 1846, whilst still at Giessen, published an important paper on "The Blue Compounds of Cyanogen and Iron," which probably contains more determinative analytical work than any other of his memoirs. In it he describes the formation of prussian blue in different circumstances, and the influence which these exercise on its composition, giving particular attention to the presence of potassium, which materially affects the colour and dyeing power of the product.

These, with two short papers, one relating to the theory of ozone, and another on the constitution of œnanthol, which he published in Liebig's *Annalen*, comprise the outcome of the Giessen period. He then passed on to Paris, where he came under the influence of Comte. It is hardly to be supposed that a man of his temperament, and in such surroundings, could remain wholly unaffected by the events of 1848. His position, however, was made secure by Graham, who came over to Paris to offer him the chair of practical chemistry in University College, to which he was appointed in 1849, and where he continued to teach for thirty-eight years.

In 1850 Williamson published his epoch-making paper on the "Theory of Ætherification." It was first read to the chemical section of the British Association at the Edinburgh meeting of August, 1850, and in its original form as "communicated by the author" occupies about seven pages of the *Philosophical Magazine*. Certainly no chemical paper of equal length ever exercised so profound an influence on contemporary thought. This memoir, although frequently referred to, is probably seldom read by the chemical student. And yet written more than half a century ago there is scarcely a term in it which needs alteration to bring it into harmony with modern chemical terminology or present day doctrine. It is a model of concise reasoning, founded upon happily devised experiment. Williamson clearly traces for us the genesis of the idea which led him to his capital discovery. His original intention was not to elucidate the theory of the manufacture of ether; he says his object in commencing his experiments was to obtain new alcohols by substituting carburetted hydrogen for hydrogen in a known alcohol, and for this purpose he acted upon sodium ethylate with the iodide of the carburetted hydrogen which was to be introduced in the place of that hydrogen—an expedient which he says he hopes may render valuable services on similar occasions. To his astonishment the compound thus formed had none of the properties of an alcohol—it was nothing else than common ether, $C_4H_{10}O$. This simple observation threw a flood of light upon the relations of alcohol and ether, which Williamson proceeded to develop by a train of reasoning, and to prove by a series of experiments which are now among the commonplace observations of every lecturer in organic chemistry wherever the science is taught. Williamson not only illustrated these relations by arguments and proofs which are absolutely unassailable, but by a course of reasoning which instantly riveted the attention and secured the adhesion of the whole chemical world, he demonstrated the true process of etherification, and thereby reconciled the teaching of apparently irreconcilable facts. It must have been with a special gratification that the young man of twenty-six penned the following lines, which happily summarise the position he had attained.

"Innovations in science frequently gain ground *only* by displacing the conceptions which preceded them, and which served more or less directly as their foundation; but, if the view which I have here presented be considered a step in our understanding of the subject, I must beg leave to disclaim for it the title of innovation; for my conclusion consists in establishing the connection and showing the compatibility of views which have hitherto been considered contrary; and the best possible justification of the eminent philosophers who advocated either one of the two contending theories, is thus afforded by my reconciling their arguments with those of their equally illustrious opponents." An observation no less tactful than true.

The paper is epoch-making in more senses than one. In it Williamson not only foreshadowed his adherence to the doctrine of types which in his subsequent teaching he did so much to elucidate and extend, but he

likewise seeks to import into the general process of chemical action the conceptions of dynamics. The simple words with which he concludes his paper sound somewhat archaic to-day, but fifty-four years ago they must have startled the members of Section B. "In using the atomic theory, chemists have added to it of late years an unsafe, and as I think, an unwarrantable hypothesis, namely that the atoms are in a state of rest. Now this hypothesis I discard, and reason upon the broader basis of atomic motion."

Williamson was not a prolific writer, and his fame mainly rests upon his work of this period and upon what he achieved during the first ten years of his professorial activity. He published comparatively little between 1854 and 1864, but under the stimulus of the new movement, he took an active part in the formulation of what is still current doctrine, and produced a series of papers on the principles of chemical classification, valency, and nomenclature which exercised a powerful influence on chemical teaching in this country.

Williamson was elected into the Royal Society in 1855, and served on the council from 1859 to 1861, again from 1869 to 1871, and for a third time from 1873 to 1890, during which period he acted, as already stated, as foreign secretary. In 1889–1890 he was made a vice-president. In 1862 he received a Royal medal. He was twice president of the Chemical Society—viz., in 1863–65 and again in 1869–71, and was one of the six presidents who had been fellows of the Society for upwards of half a century who were present at the memorable banquet in 1898. He was largely instrumental in establishing the present series of abstracts of foreign chemical literature which form so valuable a feature of the *Journal* of the Chemical Society.

In 1873 he was president of the British Association.

His merits as a man of science received wide-spread recognition. He was an honorary graduate of Dublin, Edinburgh, and Durham, a member of the Institute of France and of the Berlin Academy, and of many scientific societies on the Continent and in America.

T. E. THORPE.

ÉMILE DUCLAUX.

IN the death of Émile Duclaux science has lost one of her most devoted and brilliant workers. His career has formed the principal link between the bacteriology of the present day, and what may be called the heroic period in the history of micro-biology which followed on the unveiling, by the genius of Pasteur, of the secret of fermentation, and the consequent opening out of avenues through which innumerable problems could be successfully attacked.

The Pasteur Institute will in particular mourn its loss, for, owing to the charm of his personality and the extraordinary catholicity of his scientific enthusiasms, he was a worthy successor to the great leader, and the continuance of that brotherliness which was such a striking feature among the little community of scientific investigators in the Rue Dutot must in considerable measure be attributed to his influence.

Duclaux was born at Aurillac, on June 24, 1840. He was not a son of fortune, and it was only by dint of hard struggle and a determination which was capable of much self-denial that he succeeded in becoming a *Normalien* in 1859. At the Ecole Normale he studied principally chemistry and physics, and left the school as *Agrégé* in 1862.

At that time Pasteur, who had returned to the Ecole Normale as director of scientific studies, had recently established the positions of Agrégés préparateurs, whereby an able and earnest young graduate might remain for a few years as a research-assistant to one of his masters.

For some three years Duclaux remained préparateur to Pasteur, and was his first lieutenant during the celebrated investigations into the causes of diseases in wine and into the silkworm disease, which had nearly ruined some of the Departments of France.

In 1865 he became Docteur ès Sciences, presenting a thesis upon fractional distillation. In the same year he was appointed a professor at the *lycée* in Tours, and during the following year became acting professor of chemistry at Clermont. It was at Clermont that Pasteur stayed with Duclaux during the troublous times of the war, and it was here that the intimacy and affection which ceased only at the death of Pasteur was established between them. It was at Clermont, also, that he numbered among his students Roux, whom he introduced to Pasteur.

From Clermont, Duclaux went to Lyons as professor of physics, where he remained until he accepted, in 1878, the chair of physics and meteorology at the Institute Agronomique in Paris. In 1886 he became professor of biological chemistry at the Sorbonne, which position he held until his death. When the Pasteur Institute was completed, he transferred his classes to the Rue Dutot. At the death of Pasteur, Duclaux was elected to succeed him as director, and for the last nine years the great work of the Institute has been developed under his guidance. He, however, has not taken any direct part in that portion of its activities dealing with infective diseases, but has confined himself more particularly to the chemical and industrial side of micro-biology.

When one considers the scientific work of Duclaux, the first and most striking point is the wide range of subjects it includes. Trained as a chemist and physicist, he has occupied chairs in both these subjects, and has published a not inconsiderable number of original researches in the domains of pure chemistry and physics. At the same time his most important work was biological. Like Pasteur, he was a chemist who worked at biology, but principally at that department of biology dealing with the physiology of micro-organisms and the chemistry of enzymes, and he brought his training in the exact sciences to bear upon investigations of a biological character, with the greatest success.

The list of his original contributions to scientific journals contains upwards of eighty papers, and includes papers on molecular physics, chemistry, meteorology, physiology of digestion, enzymes, vegetable physiology, bacteriology, and technological papers on milk, butter, wine, sericulture; and he is also the author of several books. In "Ferments et Maladie" and "Le Microbe et la Maladie" he gave popular expositions of the results achieved by the Pasteurian method, and the complete change thereby produced in the standpoint from which infectious diseases were regarded.

In 1896, Duclaux published his "Pasteur, Histoire d'un Esprit," which deals with the researches of the great master from first to last, pointing out the condition of knowledge on the various subjects before Pasteur had brought them, one by one, under the influence of his imagination and accurate experimentation. This forms one of the most brilliant descriptions of the operation of scientific method in unravelling the relationship of phenomena; its perusal might well form a portion of the education of every student of science.

The most important of Duclaux's published books is the "Traité de Microbiologie"—the four volumes of which appeared during the years 1898 to 1901—each chapter of which bears the stamp of the author's individuality, and contains many original observations not

published elsewhere. "L'Hygiène sociale" embodies a series of lectures given at the École des hautes Études sociales, in which he points out forcibly that the development of our knowledge regarding the causation of disease has devolved upon us new responsibiliities as individual citizens, and in which he advocates an intelligent propagandism rather than legal insistence.

On one occasion Duclaux felt himself constrained to leave the peaceful search after truth which he had been pursuing all his life in his laboratories, and to enter upon the turmoil of the public platform. This was on the occasion of the Dreyfus case, when, thinking the cause of truth was imperilled, he, with complete disregard of all personal considerations, and, as it happened, with most disastrous consequences to his health, threw himself into that fierce struggle with invincible ardour. He, with Zola, Grimaux, and some other *intellectuels*, founded the Ligue des Droits de l'Homme, and it was whilst addressing a meeting of this League that he was seized with an attack of apoplexy. He made a slow recovery, and regained sufficient health to resume his work at the Institute, but has now succumbed to a second seizure from which he never regained consciousness.

Owing to the versatility of his genius and the wide field of scientific subjects which occupied his attention during a very active life, it is difficult to form an adequate estimate of the importance of his scientific work. It will be, perhaps, on account of his researches into the ferments and the chemical processes associated with the life and activities of micro-organisms that he will be best remembered by the world of science; but for those who have had the privilege of being his pupils and associates it will be the memory of the kindly guide and critic, whose enthusiasm was a continual spur to effort, and whose ideas were ungrudgingly at the disposal of every disinterested inquirer into truth, that will remain for ever foremost. CHARLES J. MARTIN.

SIR H. M. STANLEY.

THE death of Sir H. M. Stanley on Tuesday, at sixty-three years of age, deprives the world of a man of action, and geography of one of its greatest pioneer explorers. It can truly be said that he changed the map of Africa by the results of his expeditions, and his picturesque narratives created public interest in the problems of African exploration.

Stanley's adventures in Central Africa while engaged in the search for Livingstone attracted great attention, and his famous book, "How I Found Livingstone," in which the expedition is described, has become a classic work of travel. Commissioned to find Livingstone, of whom nothing had been heard for two years, Stanley reached Zanzibar in January, 1871, and on November 10 of the same year met the explorer at Ujiji, on Lake Tanganyika, where Livingstone had just arrived from Nyangwe. The two travellers explored together the north end of Tanganyika, and proved conclusively that the river Rusizi flowed into and not out of the lake, and that Tanganyika had no connection with the Nile system. In February, 1872, Livingstone started on the journey from which he never returned, and Stanley made his way back to Europe.

In 1874, Stanley left England for the expedition to Central Africa which has immortalised him. The writer of the obituary notice in the *Times*, from which some of the particulars here given have been derived, points out that little more than the position of Victoria Nyanza was then known; its shape was all wrong; our knowledge of Albert Nyanza was incomplete; Lake Tanganyika was imperfectly defined; and nothing was known of the region that lies between Lakes Albert and Tanganyika. Stanley's expedition changed all that. He proceeded from Bagamoyo west and north to Victoria Nyanza, tracing a river which he believed (erroneously, we now know) was the remote source of the Nile. He circumnavigated the lake, and for the first time proved to satisfaction that it was one great lake and not a group of small lakes, and that its shape was very different from that laid down in Livingstone's map. Westwards to Muta Nzige, as Lake Albert is called by the natives, Stanley and his great following marched. They struck a bay (Beatrice Gulf), which is now recognised as part of a southern lake, afterwards named by Stanley Lake Albert Edward. Important rectifications and additions were made in the country lying between Victoria Nyanza and the lakes to the west, and thence south to Ujiji. Stanley circumnavigated Tanganyika, rectifying its contour, and proving conclusively that the lake had an outlet in the river Lukuga.

Leaving Nyangwe in November, 1876, Stanley reached Boma, near the mouth of the Congo, in August, 1877. This journey across Africa lasted two years and nine months. The results to geography were certainly immense; it is doubtful if on any other single expedition so much had been done to fill up the great blank in the map of Africa. The narrative of this expedition was given by Stanley in "Through the Dark Continent."

The magnitude of Stanley's discovery we are only now realising, when the multitude of mighty tributaries north and south are being opened up, and we are able to form an estimate of the vast basin of the Congo.

Stanley had scarcely landed in Europe, in 1878, when the King of the Belgians solicited his aid in the opening up of the Congo. In the following year he returned to the Congo; and this was the beginning of what really soon became the Congo Free State, under the sovereignty of the King of the Belgians.

In 1887, Stanley went again to Africa—this time in search of Emin Pasha. Emin was found, but the expedition met with several disasters. Finally, marching through new country, exploring the Semliki River, Mount Ruwenzori, and Lake Albert Edward, Stanley and his followers made their way by the south of the Victoria Nyanza to the coast, he reaching Zanzibar on December 6, 1888, leaving Emin behind on the mainland.

On this expedition Stanley succeeded in solving some important problems in the hydrography of Africa and adding much to our knowledge of its geography. Among the geographical results were the discovery of the Semliki River, which issues from Lake Albert Edward and enters the south end of Lake Albert Nyanza, the Ruwenzori range between these two lakes, and the south-western extension of Lake Victoria. The results of this expedition are described in the volume "In Darkest Africa."

Stanley has been termed "the Bismark of African exploration," and in many respects the comparison is not inappropriate; for the work he accomplished united into one great whole the *disjecta membra* of African exploration, and it was carried out with firm nerve and unflinching will.

INTERNATIONAL ASSOCIATION OF ACADEMIES.

THE following is a list of the delegates who, according to the latest advices, will attend the General Assembly of the International Association of Academies, to be held at the Royal Society's Rooms at Whitsuntide:—

Amsterdam.—Koninklijke Akademie van Wetenschappen, Prof. H. G. van de Sande Bakhuyzen and Prof. M. J. de Goeje. *Berlin.*—Kgl. Preussische Akademie der Wissenschaften, Prof. H. Diels, Prof. W. Waldeyer, Prof. W. von Bezold and Prof. R. Pischel. *Brussels.*—Académie

Royale des Sciences, Prof. Léon Fredericq and Prof. Chevalier Edouard Descamps. *Budapest.*—Magyar Tudomanyos Akademia, M. Charles Than and M. Ignatius Goldziher. *Christiania.*—Videnskabs Selskabet, Prof. H. Mohn and Prof. G. Guldberg. *Copenhagen.*—Kongelige Danske Videnskabernes Selskab, Prof. J. L. Heiberg and Herr Paulsen. *Göttingen.*—Königliche Gesellschaft der Wissenschaften, Prof. E. Ehlers, Prof. F. Leo, Prof. F. Kielhorn and Prof. E. Riecke. *Leipzig.*—Kgl. Sächsische Gesellschaft der Wissenschaften, Prof. Dr. Flechsig and Prof. Dr. Credner. *London.*—Royal Society, Sir William Huggins, Mr. A. B. Kempe, Prof. Larmor, Mr. Francis Darwin, Sir Michael Foster, Lord Kelvin, Prof. Armstrong, Mr. George Darwin, Prof. Forsyth, Sir David Gill, Prof. Liversidge, Sir Norman Lockyer, K.C.B., Prof. Schuster, Dr. Waller, Sir William Ramsay, K.C.B., Mr. Bateson and Prof. Milne. *London.*—The British Academy for the Promotion of Historical, Philosophical, and Philological Studies, Lord Reay, Right Hon. James Bryce, Sir R. C. Jebb, Dr. Caird, Sir C. P. Ilbert, K.C.S.I., Right Hon. Sir A. Lyall, G.C.I.E., K.C.B., and Prof. Rhys Davids. *Madrid.*—Real Academia de Ciencias, Señor José Echegaray and Prof. Santiago Ramon y Cajal. *Munich.*—Kgl. Bayerische Akademie der Wissenschaften, Prof. Ferdinand Lindemann and Prof. Karl Krumbacher. *Paris.*—Académie des Inscriptions et Belles Lettres, M. Georges Perrot, M. Emile Senart, M. le Comte de Lasteyrie, M. H. Omont, M. M. Collignon and M. J. Lair. *Paris.*—Académie des Sciences, M. Mascart, M. Gaston Darboux, M. Henri Poincaré, M. H. Moissan, M. A. de Lapparent and M. A. Giard. *Paris.*—Académie des Sciences Morales et Politiques, M. Georges Picot, M. Paul Leroy-Beaulieu, M. Glasson, M. le Comte de Franqueville, M. Boutroux, M. le Baron de Courcel, M. Henri Joly and M. Paul Meyer. *Rome.*—R. Accademia dei Lincei, Prof. Giacomo Ciamician and Count Ugo Balzani. *St. Petersburg.*—Académie Impériale des Sciences, Msr. A. S. Famintzin and Prof. C. H. Salemann. *Stockholm.*—Kongl. Vetenskaps Akademien, Prof. G. Retzius and Prof. S. E. Henschen. *Vienna.*—Kaiserliche Akademie der Wissenschaften: A.—Mathematish-naturwissenschaftliche Klasse, Prof. Viktor von Lang, Prof. Sigmund Exner, Dr. Edmund Mojsisovics, Edler von Mojsvar, and Prof. Heinrich Obersteiner. B.—Philosopisch-historische Klasse, Prof. Theodor Gomperz, Prof. Joseph Karabacek and Prof. Leopold von Schroeder. *Washington.*—National Academy of Sciences: its foreign members—Sir Archibald Geikie and Prof. E. Ray Lankester.

NOTES.

The following candidates selected by the council of the Royal Society were duly elected at the meeting on Thursday last, May 5:—Dr. T. G. Brodie, Major S. G. Burrard, Prof. A. C. Dixon, Prof. J. J. Dobbie, Mr. T. H. Holland, Prof. C. J. Joly, Dr. Hugh Marshall, Mr. Edward Meyrick, Dr. Alexander Muirhead, Dr. G. H. F. Nuttall, Mr. A. E. Shipley, Prof. M. W. Travers, Mr. Harold Wager, Mr. G. T. Walker, and Prof. W. W. Watts.

An influential committee has been formed for the purpose of striking a medal in honour of the memory of the late Prof. Cornu. The committee includes many members, foreign associates and correspondants of the Institute of France, as well as other leaders in the scientific world. The medal will be in bronze, silver bronze and silver, and the price will be 15 francs, 20 francs, and 50 francs respectively. Subscribers for the medal are invited to send their subscriptions to M. E. A. Martel, 8 rue Ménars, 2e Arrondissement, Paris.

At its meeting on Monday, May 9, the Academy of Sciences of Paris elected Prof. Barrois, of Lille, to fill the vacancy left in the section of mineralogy by the death of the illustrious Fouqué. This recognition of the claims of one of the most distinguished geologists of the present day will be welcomed far and wide, and nowhere more warmly than in the British Isles, where M. Barrois has many attached personal friends, and where he has himself done so much to illustrate the geology of this country.

As was generally expected, Prof. Rothpletz has been appointed to the chair of geology in the university at Munich and to the directorship of the State geological collections—the posts left vacant by the death of the lamented K. von Zittel. He has long been connected with the university, and has gained a wide reputation as an accomplished field geologist and a good palæontologist. His researches into the tectonics of the Alps have attracted much attention in this country, where he has many personal friends, and where he has made many geological excursions.

At a meeting of the U.S. National Academy of Sciences on April 21, Sir William Ramsay, K.C.B., was elected a foreign associate of the academy.

A Reuter message from Cape Town reports the arrival there of the steam yacht *Scotia*—the vessel in which the Scottish Antarctic Expedition sailed.

The death is announced of Mr. Eli Sowerbutts, who for the last twenty years had acted as secretary of the Manchester Geographical Society, which he was largely instrumental in founding. Mr. Sowerbutts was in his seventieth year.

Prof. Émile Bourquelot, of Paris, Sir Henry Littlejohn, and Dr. J. Wilson Swan, F.R.S., have been elected honorary members of the Pharmaceutical Society of Great Britain. The following have been elected corresponding members of the society:—Prof. E. Perrot, Paris; Prof. Heinrich Beckurts, Brunswick; Prof. Carl Hartwich, Zürich; Mr. S. T. Dunn, of the Hong Kong Botanical Gardens; and Dr. G. W. Parker, British Guiana.

The following have been elected honorary members of the Royal Institution:—Prof. E. H. Amagat, Prof. L. P. Cailletet, Prof. J. M. Crafts, Prof. H. A. Lorentz, Prof. E. W. Morley, Prof. E. C. Pickering, Prof. and Madame Curie, Prof. H. L. Le Chatelier, Prof. G. Lippmann, Prof. J. W. Bruhl, Prof. G. H. Quincke, Prof. E. Fischer, Prof. F. W. G. Kohlrausch, Prof. H. Landolt, Prof. L. Boltzmann, Dr. H. Kamerlingh Onnes, Dr. G. Lunge, Prof. P. T. Cleve and Prof. P. Zeemann.

Prof. van 't Hoff offers through the medium of the *Zeitschrift für physikalische Chemie* a prize of 60*l.* for the best and most complete synopsis of the literature of catalytic phenomena. Competitors are required to send in their papers before June 30, 1905, to the editors of the *Zeitschrift*, 2 Linnéstrasse, Leipzig, and the judges are Profs. van 't Hoff, Arrhenius and Ostwald.

An international congress on philosophy has been arranged to take place at Geneva from September 4 to 8 under M. Ernest Naville as honorary president and Prof. Gourd as acting president. The languages used will be English, French, German and Italian. The congress will be divided into five sections, dealing with history of philosophy, general philosophy and psychology, applied philosophy, philosophy of the sciences, and history of science. The secretary is Dr. Ed. Claparède, 11 Champel, Geneva.

The British Fire Prevention Committee offers a gold medal and a purse of 20*l.* for the best fable for children calculated to serve as a warning against the danger of

playing with matches or fire. Two silver and four bronze medals will also be given as additional awards for meritorious essays. The conditions can be obtained at the committee's offices, 1 Waterloo Place, London, S.W., upon application by letter, enclosing a stamped addressed envelope.

FOLLOWING the example of some other counties, a society has been formed for the photographic record and survey of Kent. The society is promoted by the South-Eastern Union of Scientific Societies, and its objects are "to make and preserve by permanent photographic prints, records of the present condition of objects of archæological, historical, or scientific interest · the geology, fauna, and flora of Kent; the customs and costumes of its people, notable events, and portraits of its prominent men and women." Good promise of support has already been received, and a successful first exhibition in June seems assured, but further help is desired. The organising secretary (*pro tem.*) is Mr. H. Snowden Ward, Hadlow, Kent.

A CORRESPONDENT of the *Times* directs attention to some of the geographical work done by the late Admiral Makaroff. In the early eighties of last century, Makaroff wrote a brochure of 147 pages, with nine charts, on the interchange of the waters of the Black Sea and Mediterranean, which was published by the Russian Academy of Sciences and awarded a full premium. On his return from his voyage in the *Vitiaz* in 1893 he wrote a report of his observations—848 pages and 33 charts. The report was likewise published and awarded a full premium by the Russian Academy. In 1901 he published an account of his ice-breaking steamer the *Yermak* and her work under the title of "The *Yermak* in the Ice."

WE are not concerned in these columns with the cause or course of the war between Japan and Russia, but it is impossible to read of the remarkable achievements of the Japanese without remembering that they owe their success to the encouragement of education and science. A writer in the *Daily Graphic* points out that while probably 95 per cent. of the Russian soldiers are illiterate, not more than 5 per cent. of the Japanese are illiterate, and he attributes the Japanese successes to their intelligence and initiative. It does not seem possible for the Russian soldiers to be placed in dispersed positions to think and act for themselves. "As for the officers," the writer continues, "where is genius to come from? The broad, liberal-minded men have been sent to Siberia, and all who have shown the characteristic mark of leadership in its contempt for bureaucracy have set a seal on their careers." Whatever may be said about Russia, it is certain that Japan is now furnishing the world with an example of "the influence of brain-power on history." Last September Sir Norman Lockyer referred in his British Association address to "the intellectual effort made by Japan, not after a war, but to prepare for one." Recent events have shown that the nation which endows universities and encourages science is making the best possible provision for military or naval conflict as well as for industrial competition.

IN the death of Dr. Charles Ricketts, at the advanced age of eighty-six, geological science has lost an ardent local worker, who practised as a physician for many years at Birkenhead, and devoted his leisure to the study of geology, more especially in Cheshire and Lancashire. He was twice president of the Liverpool Geological Society, and most of his geological papers were published in the *Proceedings* of that society. An interesting article, which he communicated in 1883 to the *Geological Magazine*, was on the influence of accumulation and denudation in causing oscillation of the earth's crust; in this he embodied deductions made and published by him as early as 1865. Dr. Ricketts was for many years a regular attendant at the meetings of the British Association.

THE fossil foot-prints of the Jura-Trias of North America form the subject of a memoir by Dr. R. S. Lull (*Mem.* Boston Soc. Nat. Hist., vol. v., No. 11, April). Two groups of foot-prints have been found impressed on the ancient shales and sandstones, the one bipedal and the other of quadrupedal gait. Both groups are considered to belong to dinosaurs. These are the only vertebrates the gait of which when erect could have been a true walk or run with alternating steps, which without exception the bipedal tracks show, there being no instance of the record of a jumping form. Of the truly quadrupedal forms, those referred to Batrachopus may have belonged to a true dinosaur which had retained, among other primitive characters, the ancestral quadrupedal gait. The mode of progression was a true walk like that of a mammal, and not the crawl of modern reptiles.

THE Geological Survey has issued a colour-printed drift map of the area around London, on the scale of one inch to a mile, in four sheets, price 1*s.* 6*d.* each. The execution of this map has been carried out at the Ordnance Survey Office, and the colour printing is in all respects excellent. The map is intended to replace the old hand-coloured geological map of London and its environs, the cost of which was 30*s.* This reduction in price will be a boon to all interested in the geology of the metropolitan district. The new map does not cover quite so large an area as the old one, but it extends on the north to Watford, Enfield, High Beech and Kelvedon Hatch; on the east to Brentwood, Upminster, West Thurrock, Greenhithe and Kingsdown; on the south to Shoreham, Croydon, Sutton, Ewell and Byfleet; and on the west to Chertsey, Staines, Uxbridge and Rickmansworth. The results of a recent six-inch survey of the Thames valley deposits have been incorporated on the new map, the brickearths not having previously been accurately defined.

WE have received from the president of the International Aëronautical Committee a summary of the balloon and kite ascents made in various countries during the months of January to March. Among the highest altitudes reached we may mention the ascents from Paris, 15,000 metres; Pavia, 13,000 metres; Strassburg, 15,500 metres; Munich, 13,000 metres; Pavlovsk, 18,960 metres; Guadalajara, 13,220 metres; and Zürich, 14,430 metres. Mr. Dines's kite at Oxshott attained an altitude of 1100 metres. The meteorological results are reserved for future discussion; unfortunately several of the records have not been recovered.

THE daily weather report issued by the Meteorological Office on May 4 contains a small inset chart showing the total amount of rainfall recorded in the United Kingdom in the seventeen weeks ended April 30, together with the percentage of the average amount. In all districts excepting the north-east of England the fall has been in excess of the average. In the extreme north (Scotland) the amount is 121 per cent. of the average, and in the extreme south (Channel Islands) 144 per cent.; in the north-west of England it is 122 per cent. In Ireland the amount is 126 per cent. in the north and 116 per cent. in the south. In the east and north-east of England the fall has been practically normal.

A letter received from Mr. W. Comery, Llandilo, Carmarthenshire, gives an account of variations noted in the parts of the flower of the primrose during the current year, and provides data for comparison with the observations recorded by Mr. T. G. Hill in the *Annals of Botany*, June, 1902. According to our correspondent, variation in the number of parts was confined to 4 and 6, except in the cases where one flower had 8 sepals, 7 petals, and 6 stamens, two were decamerous, and one was trimerous. The corolla showed the greatest amount of variation; of ninety-four irregular flowers, 79 per cent. showed reduction in the number of petals, and the proportion of long styled to short styled was nearly 7 : 3, but of twenty flowers showing increase in the number of petals the proportion was exactly inverse.

An extensive series of observations on the number of fungus spores present in the air has been made by Mr. K. Saito (*Journ.* of the College of Science, Imp. Univ., Tokyo, Japan, xviii., art. 5). The observations were made in the Botanic Garden, streets, operating theatre of the hospital, and certain rooms. It was found that the spores were more numerous in warm and damp than in cold and dry weather, and that rain and snow diminished while a strong wind increased their number. The commonest species were *Cladosporium herbarum, Penicillium glaucum* and *Epicoccum purpurascens*. Three new species are described. The article is illustrated with charts and a number of figures; the latter would prove useful in the identification of the species of fungi that might be met with in laboratories, &c.

With the exception of one on field-practice with the aneroid, and a second on the moths of the family Geometridæ, the articles in the second part of vol. xvi. of the *Proceedings* of the Royal Society of Victoria are devoted to palæontological and geological subjects. Three of these are communicated by Mr. F. Chapman, who describes Jurassic Foraminifera and Ostracoda from W. Australia, Palæozoic and Mesozoic invertebrates from W. Australia and Queensland, and various Palæozoic fossils from Victoria. Mr. C. M. Maplestone discusses the fossil Selenariidæ of the last named colony.

According to the report for last year, the hatching of sea-fish at Piel has been most successful, nearly 15,000,000 fry having been obtained from about 17,000,000 eggs. This gives a total loss of rather less than 11 per cent. for the whole operations, which is almost certainly vastly below what occurs in nature. It is incidentally mentioned by Prof. Herdman that plaice in the closed Scotch waters have been found to run much larger than on the over-fished Lancashire coast. The feature of the report under consideration—namely, that on the Lancashire Sea-Fisheries Laboratory—is, however, undoubtedly Dr. J. H. Ashworth's elaborate and beautifully illustrated account of the life-history and structure of the lug-worm, which is the result of several years hard and careful work.

Among recent mathematical papers published in the United States may be noticed the following:—L. E. Dickson, determination of all the subgroups of the known simple group of order 25920 (*Trans.* Amer. Math. Soc., v. p. 126); C. N. Haskins, on the invariants of quadratic differential forms (*ibid.*, p. 167); C. Arzelà, note on a series of analytic functions (*Ann. of Math.* (2), v., p. 51); A. G. Greenhill, the mathematical theory of the top (*ibid.*, p. 67); H. A. Converse, on a system of hypocycloids of class three (p. 105); E. B. Wilson, projective and metric geometry (p. 145); W. F. Osgood, on a gap in the ordinary presentation of Weierstrass's theory of functions (Amer. Math. Soc. *Bull.*, March). The first number of vol. xxvi. of the *American Journal of Mathematics* is accompanied by a portrait of Prof. Noether; its principal contents relate to the theory of groups, but there is a paper by Prof. Bromwich on caustics which is of a less abstract character.

Messrs. J. and A. Churchill have published a sixth edition of "A Manual of Dental Anatomy: Human and Comparative," by Mr. Charles S. Tomes, F.R.S.

Messrs. Iliffe and Sons, Ltd., have published sixth editions of "Photography for All," by Mr. W. Jerome Harrison, and of "Practical Enlarging," by Mr. John A. Hodges. The price of each book is 1s. net.

A sixth edition of "A Treatise on Hydromechanics. Part i. Hydrostatics," by Dr. W. H. Besant, F.R.S., and Mr. A. S. Ramsey, has been published by Messrs. George Bell and Sons. For the present edition the text has been carefully revised, and considerable additions have been made to some sections of the book.

A second edition of Mr. T. W. Cowan's "The Honey Bee: its Natural History, Anatomy, and Physiology," has been published by Messrs. Houlston and Sons. The first edition was reviewed at length in our issue of April 23, 1891 (vol. xliii. p. 578). It is consequently only necessary to add that the present edition has been revised and corrected.

The delegates of the Clarendon Press have taken over the series of geographical memoirs known as "The Regions of the World," which is under the general editorship of Mr. H. J. Mackinder, and in future this series will be published by Mr. Henry Frowde. Two new volumes will be issued this year—"North America," by Prof. Israel Russell, of the University of Michigan, at the end of this month, and "India," by Sir Thomas Holdich, K.C.I.E., in the early autumn. It is hoped that "The Far East," by Mr. Archibald Little, will soon be in the press.

In the March number of the *Journal of Physical Chemistry*, Messrs. H. E. Patten and W. R. Mott describe experiments on the electrolytic deposition of metallic lithium from solutions of lithium chloride in ethyl, propyl, butyl and amyl alcohols. By the use of organic solvents the electrolytic separation of metals not obtainable from aqueous solutions seems possible in many cases.

In the April number of the *American Chemical Journal* Messrs. H. C. Jones and F. H. Getman discuss the nature of concentrated solutions of electrolytes. As the result of an extended investigation of the freezing points, boiling points and conductivities of such solutions, the authors arrive at the conclusion that combination takes place between the solvent and the dissolved substance. As a consequence of this, such solutions are really more concentrated than they would appear to be from the amount of dissolved substance present in them, and many of the discrepancies exhibited by concentrated solutions are explainable.

The April number of the *New Philosophy*, published by the Swedenborg Scientific Association, contains some interesting notes in reference to Swedenborg's work in chemistry. Whilst Prof. van 't Hoff acknowledges it as the first work which anticipated the modern science of stereochemistry, others regard Swedenborg's work as having had absolutely no influence upon chemical thought or discovery. Prof. F. W. Clarke recently described it as "the

prototype of a class of speculative treatment, considerable in number, some of them recent, and all of them futile."

IN the current number of the *Zeitschrift für anorganische Chemie*, Prof. B. Brauner describes the preparation and properties of acid sulphates of the rare earths. The cerium salt has the formula $Ce_2(SO_4)_3.3H_2SO_4$, and salts of the same type have also been obtained for lanthanum, praseodymium, neodymium, samarium and yttrium. These acid sulphates are only incompletely converted into the normal salts at high temperatures, and the author's opinion is that all atomic weight determinations of the rare earth metals, in which the sulphates obtained synthetically have been employed, are on this account inaccurate.

IN the March number of the *Physical Review*, Mr. T. E. Doubt describes some experiments dealing with the effect of the intensity on the velocity of light. The results of these experiments justify the conclusion that for light travelling in air a change in intensity in the ratio of 1 to 290,000 does not alter its velocity by as much as 57 centimetres per second. In the case of water, a change in intensity in the ratio of 1 to 43,000 does not alter the velocity by as much as 80 centimetres per second, that is, by 1 part in 1000 million parts.

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus*) from India, presented by Mrs. Mackenzie Fraser; a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, presented by Mr. Arthur Collins; a Ruffed Lemur (*Lemur varius*) from Madagascar, presented by Lady Constance Stewart Richardson; a Pigmy Hog (*Porcula salviana*) from Bhotan, presented by Mr. D. H. Felce; two Markhoors (*Capra megaceros*) from North-east India, two Punjaub Wild Sheep (*Ovis cycloceros*) from North-west India, presented by Colonel Deane; three Chinchillas (*Chinchilla lanigera*) from Chili, presented by Mr. Andres Ker; two Coypu Rats (*Myopotamus coypus*) from South America, presented by Mr. H. L. Horsfall; two Ring-tailed Pigeons (*Columba caribbaea*) from Jamaica, presented by Mr. D. Seth-Smith; two Spur-winged Geese (*Plectropterus gambensis*) from West Africa, presented by Mr. J. Lemberg; two Nutmeg Fruit Pigeons (*Myristicivora bicolor*) from Moluccas, two Imperial Nicobar Fruit Pigeons (*Carpophaga insularis*) from the Nicobar Islands, four Andaman Teal (*Nettion albigulare*), three Andaman Banded Crakes (*Rallina canningi*), six Great-billed Andaman Parrakeets (*Palaeornis magnirostris*) from the Andaman Islands, presented by the Government of India; an Exanthematic Monitor (*Varanus exanthematicus*) from West Africa, presented by Mr. Dayrell; a Rufescent Snake (*Leptodira hotambioea*) from South Africa, presented by Mr. B. McMillan; an Allen's Bassaricyon (*Bassaricyon alleni*), six Red and Black Snakes (*Erythrolampus venustissimus*) from South America, an Australian Cassowary (*Casuarius australis*), a Gould's Monitor (*Varanus gouldi*), a Lace Monitor (*Varanus varius*), a Blue-tongued Lizard (*Tiliqua scincoides*), a Derbian Wallaby (*Macropus derbianus*) from Australia, a Sooty Phalanger (*Trichosurus fuliginosus*) from Tasmania, two Australian Barn Owls (*Strix delicatula*) from Australia, an Orton's Guan (*Penelope ortoni*) from Ecuador, a Gold-crested Mynah (*Ampeliceps coronatus*) from India, a Sarus Crane (*Grus antigone*) from Northern India, five Lineated Sand Skinks (*Chalcides lineatus*), South European; four Californian Newts (*Molge torosa*) from California, deposited; a Black Ape (*Cynopithecus niger*) from the Celebes, ten Crested Pigeons (*Ocyphaps lophotes*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

SOLAR WORK AT THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY.—Incorporated in the annual report of the Smithsonian Institution, for the twelve months ending June 30, 1903, is a report of the work performed in the Astrophysical Observatory, during that period, by Mr. C. G. Abbot who is in charge.

A new horizontal telescope of 20 inches aperture and 140 feet focal length, fed by a novel form of two-mirror cœlostat, and fitted with an apparatus for thoroughly churning the air inside the tube during the observations, has been mounted for the bolographic study of the solar image, and especially sun-spot energy spectra and the absorption of the solar envelope.

The most notable result of the study of the atmospheric absorption during the above named period was the decreased transparency of the atmosphere, at Washington, for all wave-lengths, but especially for the violet and ultraviolet radiations. Other results showed that this result was not caused by an excess of moisture in the atmosphere. Several plates which are included in the report show a diagrammatic view of the new instrument, typical "bolographic energy" and "atmospheric transparency" curves, a curve showing the distribution of radiation in the normal solar spectrum outside the earth's atmosphere, and a photograph of the large cœlostat with the second mirror.

METEOR RADIANTS OBSERVED AT ATHENS.—A communication from Prof. D. Eginitis to No. 3941 of the *Astronomische Nachrichten* gives a list of the radiants observed at Athens during 1902. Two radiants not given in Denning's "General Catalogue" were recorded in June and July, respectively, as follows:—

June 27, 10h. 58m. – 12h. 16m. (Athens M.T.) $\alpha = 230°, \delta = +73°$
July 29, 10h. 40m. – 11h. 27m. („) $\alpha = 85°, \delta = +85°$

Several of the radiants obtained from the observations at Athens differ considerably both in time and position from their respective values given in the above named catalogue.

The observed radiant for the Perseid shower spreads over a large area, and the principal centre, situated near to η Persei, alters its position considerably. The Perseids from the region near to α Persei were generally red and bright, whilst those from near η Persei were fainter and of a reddish-yellow colour.

SOLAR FACULÆ AND PROMINENCE VARIATIONS.—In a paper communicated to No. 3, vol. xxxiii., of the *Memorie della Società degli Spettroscopisti Italiani*, Prof. Mascari analyses the latitude and frequency variations of faculæ, as observed at Catania, in a manner similar to that recently used by Sir Norman and Dr. Lockyer, whose results he corroborates, for the spots and prominences.

After discussing the data obtained from his observations in a series of tables and curves, he arrives at the following general conclusions:—(1) The zone of maximum activity of the groups of faculæ lies between the mean latitude $\pm 45°$ and the equator, and pursues a movement parallel to, and coincident with, that of the spots, but the inverse of that of the prominences. (2) The faculæ beyond the principal maximum, in the equatorial region of each hemisphere, are not represented in the polar regions. (3) The centre of maximum activity of the prominences occurs generally in the region of minor activity of the faculæ.

MAGNITUDE OBSERVATIONS OF NOVA PERSEI.—In No. 3941 of the *Astronomische Nachrichten*, Father Hagen, S.J., gives a list of the magnitudes of Nova Persei as observed at Georgetown (U.S.A.) with a 12-inch refractor, from June 19, 1901, to April 18, 1903. The magnitude on the latter date, from an observation made when the Nova was near the horizon, was 11·05.

A similar list of magnitude observations, made at Kalocsa by Father M. Esch, S.J., during the period July 8, 1901, to March 22, 1902, is given in No. 3943 of the same journal.

COMET 1904 *a*.—Numerous observations of this comet are recorded in Nos. 3943–4 of the *Astronomische Nachrichten*. Dr. Hartwig, observing at Bamberg on April 17, recorded the total magnitude as 9·0, and the magnitude of the nucleus alone as 10·0. The comet had a broad divided tail 4′ long, the mean position angle of which was 211°; the coma was 1′·5 in diameter.

The following is a continuation of the ephemeris published by Herr M. Ebell:—

Ephemeris 12h. M.T. Berlin.

1904		α		δ
		h. m. s.		° ′
May 22	...	14 37 10	...	+57 57
„ 26	...	14 20 29	...	+58 1
„ 30	...	14 6 26	...	+57 44

An error, due to the ambiguity of a necessarily brief telegram, was contained in a previous paragraph concerning this object. This comet is a new one discovered by Mr. Brooks, and *not* the Brooks's comet of 1896 returned.

Orbit of the Spectroscopic Binary ι Pegasi.—No. 53 of the Lick Observatory *Bulletins* is devoted to a detailed discussion of the definitive orbit of ι Pegasi by Dr. Heber D. Curtis. The elements obtained have been derived from measurements of forty-three plates taken during the period October 7, 1897, and December 1, 1903, inclusive.

Three sets of elements, each one giving a nearer approximation to the observed values than the one preceding it, were evolved, and the derivation of each set is given in full detail. The final set gives a velocity of -4.12 ± 0.11 km., and a period of 10.21312 ± 0.00006 days. Owing to the small eccentricity of the orbit, viz. 0.0085, the epoch of periastron is not very certain, but is given as 1899 June 14.966 ± 0.352 days.

IRON AND STEEL INSTITUTE.

The annual meeting of the Iron and Steel Institute was held at the house of the Institution of Civil Engineers on May 5 and 6 under the presidency of Mr. Andrew Carnegie. The report of the council, read by the secretary, Mr. Bennett H. Brough, showed that the institute continues to make satisfactory progress. The president then presented the Bessemer gold medal to Mr. R. A. Hadfield (Sheffield). The announcement was made that awards of 100*l.* from the Carnegie research fund had been made to John Dixon Brunton (Musselburgh), Dr. H. C. H. Carpenter (National Physical Laboratory), E. G. L. Roberts and E. A. Wraight conjointly (London), Frank Rogers (Cambridge), and Walter Rosenhain (Birmingham), and a renewed award of 50*l.* to O. Boudouard (Paris). The Andrew Carnegie gold medal for research was awarded to Pierre Breuil (Paris), and a special medal to Percy Longmuir (Sheffield).

The first paper read was by Mr. A. Dupré and Captain M. B. Lloyd, H.M. Inspector of Explosives, on explosions produced by ferrosilicon at Liverpool on January 12 and 21. The explosion was most probably caused by water having got into the interior of the drums containing the ferrosilicon; the gas evolved formed, with the air in the drums, an easily ignited explosive mixture, which was fired by the heat produced by the friction of the hard lumps against each other when the drums were moved about, or possibly by the spontaneous ignition of some phosphuretted hydrogen contained in a pocket in the material, and liberated suddenly by the breaking of a lump on the drum being moved. Although the accidents were not attended by very grave results, it is important that all those who have to handle ferrosilicon should be alive to the possible dangers attaching to it, and by keeping it in a dry and thoroughly well ventilated place prevent the accumulation of inflammable gas as far as possible.

Prof. H. Louis (Newcastle-on-Tyne) then read a paper on the manufacture of pig iron from briquettes at Herräng, Sweden. The mining and smelting of the ore present many novel features. Briefly the scheme of operations is as follows:—The ore as mined is conveyed from the various mines by aërial wire rope-ways to the crushing works, where it is broken and crushed wet; the pulp runs to the magnetic concentrators, which take out the magnetite; the latter is conveyed by a small aërial rope-way to the briquetting house, where it is stamped into briquettes, which pass next through the briquetting furnace, in which they are burnt; they are then hoisted up to the top of a pair of charcoal furnaces, where they are smelted for high-class pig iron; the waste gases from the blast furnace fire the briquetting furnaces, and supply gas-engines which furnish the blast and also drive the dynamos of a central electrical station, from which power is conveyed to the concentrating works, as well as to the various mines for hoisting, pumping, &c. Several of the principles embodied appear destined to play an important part in the metallurgy of iron in the near future.

Mr. Cosmo Johns (Sheffield) read a paper on the production and thermal treatment of steel in large masses. He indicated some of the conditions which differentiate works' practice from laboratory research.

An interesting feature of the meeting was an exhibition of pyrometers. At the Barrow meeting of the Iron and Steel Institute, the suggestion was made that, in view of the growing importance of pyrometers to the steel industry, arrangements should be made to enable members to see the actual working of different pyrometers in order to enable them to form their own opinions of the relative merits of the appliances available for metallurgical purposes. The council readily adopted this suggestion, and appointed a committee, consisting of Mr. R. A. Hadfield (vice-president), Mr. J. E. Stead (member of council), and Mr. B. H. Brough (secretary), to make the necessary arrangements for the exhibition. Invitations were sent to all the leading makers to exhibit pyrometers and to furnish brief descriptions of them. The descriptions occupied a pamphlet of sixty-two pages, and dealt with the following types:—(1) Baird and Tatlock pyrometer, (2) Bristol's recording air pyrometer, (3) Callendar and Griffith resistance pyrometer, (4) Le Chatelier pyrometer, (5) Mesuré and Nouel optical pyrometer, (6) Roberts-Austen recording pyrometer, (7) Rosenhain and Chalmers pyrometer, (8) Siemens electrical pyrometer, (9) Siemens water pyrometer, (10) Uehling pneumatic pyrometer with Steinbart automatic recorder, (11) Wanner optical pyrometer, (12) Wiborgh's thermophone, (13) Zaubitz pyrometer. In conclusion, a list of patents relating to pyrometry, compiled by Mr. H. G. Graves, and a full bibliography of the subject were given.

Mr. C. Lowthian Bell (Middlesbrough) read an important paper on the manufacture of coke in the Hüssener oven at the Clarence Iron Works, and its value in the blast furnace. The results show that with this oven a coke can be made giving as good results in the furnace as that made in the old beehive oven.

Dr. H. C. H. Carpenter and Mr. B. F. E. Keeling submitted a paper on the range of solidification and the critical ranges of iron-carbon alloys. The research, which was carried out at the National Physical Laboratory, confirms, broadly speaking, the accuracy of Bakhuis-Roozeboom's diagram. Further, the results indicate that the diagram will be amplified in certain parts when the equilibrium between the various phases has been more fully studied, viz. on account of (1) the small thermal change at about 790° for alloys with carbon content 0.8–4.5; (2) the slow thermal change at about 600° found over the whole range of alloys; (3) the evolutions of heat at about 900° found in alloys with carbon content of 3.87 and 4.50.

Mr. H. C. Boynton (Harvard University) submitted a paper on troostite, in which he gave the results of experiments made with the object of furnishing facts in regard to the identity of this constituent of steel, which, although mentioned by prominent metallurgists, has not apparently been generally accepted or understood.

A paper on the synthesis of Bessemer steel was presented by Mr. F. J. R. Carulla (Derby), in which he gave particulars of the manufacture of steel rails in 1874 by the acid process of a quality so uniform as to leave nothing to be desired. He urges that modern requirements should be equally well fulfilled, and that endeavours should be made to introduce improvements in the Bessemer process so as to prevent its being altogether put aside in favour of the open-hearth process.

Mr. W. J. Foster (Darlaston) submitted a paper on the thermal efficiency of the blast furnace, in which he gave the results obtained with the furnace at Darlaston 72½ feet high, in which the materials smelted are chiefly silicates of iron.

Mr. W. Rosenhain (Birmingham) contributed a paper on the plastic yielding of iron and steel. He described some new observations explaining the curved slip-bands in iron and mild steel. This curvature is shown to be probably due to a multitude of minute steps, and a reason is thus

suggested why this stepping should be so marked a feature in iron, while it is so comparatively rare in certain other metals. This reason is that the ferrite crystals in ordinary iron and steel are formed by crystallisation from a solid solution, while the ordinary crystals of lead, for instance, are formed by crystallisation from a true liquid. The truly crystalline character of slip-bands is further demonstrated in a novel manner by the observation of slip-bands in iron following and revealing the gliding planes of twin crystals. Finally, the view has been advanced that the strength of inter-crystalline cohesion in pure metals and certain forms of alloys is due to the interlocking of the skeleton arms which the crystals develop during their first formation. According to this view, the inter-crystalline boundaries take the form of regions of mixed orientation, and certain consequences are to be deduced from this consideration. It is argued that, since a region of mixed orientation must offer greater resistance to slip than a region of uniform orientation, the inter-crystalline boundaries form a network of cells upon which the true resistance of the metal depends. Plastic deformation sets in when these cell-walls begin to give way; in doing so they carry with them the less resisting masses of the crystalline grains. In this way the observed relation between slip-bands and inter-crystalline boundaries is explained. Observations of a frequent doubling of the inter-crystalline boundaries between ferrite grains in pure iron and the "bordered boundaries" and "spines" in strained metal are adduced as further evidence in support of this view of the structure of inter-crystalline boundaries.

Mr. B. H. Thwaite (London) contributed a paper on the use of steel in American lofty-building construction. During the past five years some 200,000 tons of steel have been annually consumed in steel frame construction in the United States.

Mr. P. Breuil (Paris) submitted a report on the work carried out by him as a Carnegie research scholar. It dealt with the relations between the effects of stresses slowly applied and of stresses suddenly applied in the case of iron and steel. He showed that the tests made with nicked bars, a widely extending practice in France, were just like those made with plain bars, but much less clear and precise. The nicking of test bars simply introduces a further complication.

Mr. P. Longmuir (Sheffield) submitted a report on his research, as a Carnegie scholar, on the influence of varying casting temperature on the properties of steel and iron castings. With mild steels the influence of casting temperature does not appear to show on the tensile properties. Low casting temperatures, however, appear to induce a type of brittleness not evidenced in the tensile test, but shown in the working life of the metal. It is possible that many of the mysterious fractures of steel, which has previously passed a rigorous inspection, may be traced to the original ingot having been cast at too high or too low a temperature.

THE SOUTH AFRICAN ASSOCIATION.

THE second annual meeting of the South African Association for the Advancement of Science was held at Johannesburg during the week commencing April 4. At the opening meeting Lord Milner presided, and Sir Charles Metcalfe delivered his presidential address, which, in addition to a review of the scientific advances during the preceding year, contained a number of comments on some of the causes which have effected the great advances in scientific knowledge in recent years.

Portions of the address appeared in the Johannesburg *Star*, and we have selected from them a few extracts of scientific interest. The only address which has reached us is one given by Mr. E. B. Sargant on "The Education of Examiners," and an abridgement of this will probably appear in our next number. For the subjoined abstracts of other addresses and papers we are indebted to the Johannesburg *Star*.

Presidential Address.

Referring to diseases of stock, Sir Charles Metcalfe said:—In Rhodesia, Dr. Koch has been spending the whole year in laborious and patient investigation of the African coast fever among cattle, and he has now reported that he has found that it is caused by a blood parasite which can be readily identified by a demonstration of the specific organism, that it is different from Texas fever, or so-called red-water, that it is not transferable directly, that sick animals can be stabled with healthy ones without communicating the disease, and that the disease can only be spread by ticks. Further, that the blood of animals which have recovered and become immune is not free from parasites, and that the disease therefore can be produced in healthy animals by the transfer of parasites from salted animals by means of ticks, and though fencing, dipping and spraying are beneficial, yet as they have only a temporary value, Dr. Koch recommends that these precautions should be supplemented by inoculation with the blood of animals that have recovered whenever disease breaks out in the vicinity.

Turning to another subject, the president continued:—the geodetic survey of Africa, the inception and continuation of which owe so much to our past president, Sir David Gill, is being proceeded with both in the Transvaal and in northern Rhodesia beyond the Zambezi. It is intended to extend it northwards more or less, probably along the route of the Cape to Cairo railway, that projected line which to many appears, perhaps, to belong to the things of dreamland. You, however, who know South Africa well will agree with me that in this country it has generally been found that the sanguine man has ever been the truest prophet. When this geodetic survey has been connected up with that of Europe, which has now been extended as far north as Spitsbergen, we shall have an arc from that point to Cape Town—the longest arc that is possible to us on this globe. All civilised nations have found the advantage of having proper and accurate maps, and it is hoped that a useful work may now be undertaken in South Africa by a system of secondary triangulation. This work will necessarily take many years to complete; every year, however, the recorded results will be of value, as they will enable correct maps to be compiled showing the topography and main features of the country and the situation of the larger farms, of the most important and more populated districts in the first place, and then of the more remote parts of the country.

Introducing the subject of anthropological research, the president remarked that Prof. Haddon, when president of the Anthropological Institute, expressed himself strongly on the urgency of anthropological research. "In view," he said, "of the decrease of the native races by the advance of civilisation and the changes in the habits of the survivors, no time is to be lost in the acquisition of scientific knowledge by direct observations." There is wide scope and much opportunity in South Africa for such research, though Sir Charles Metcalfe said "the argument about their decrease and the use of the word 'survivors' read strangely to us, who see the native races not decreasing but happily increasing in numbers as well as in material prosperity."

Later in his address Sir Charles Metcalfe directed attention to the fact that for research into the causes and preventives of disease, both in human beings and in animals, there is a great field in South Africa. Continuing, he remarked, "The various Governments here have shown commendable vigour in dealing with those terrible scourges, rinderpest, plague, and red-water, and have acted in a spirit of the truest economy by securing the services of the most able men of science of the day in their investigation. When England was ravaged by rinderpest, no remedy was discovered; the animals affected were simply destroyed at a cost of some nine millions of money. It was left for South Africa, at a later date, when knowledge was more advanced by the admirable work of the scientific investigators engaged on that task, to be the first to discover a preventive for that disease, a fact of which this country may well be proud. I have mentioned Dr. Koch's great work in the investigation of cattle fever in Rhodesia. He has also at the same time undertaken researches into some others of the diseases affecting animals in South Africa, amongst them that most familiar but terrible disease which we call horse-sickness, a disease by which the country loses not only many thousands of pounds annually by the deaths of valuable animals, but also the large amount

that otherwise might be realised by the breeding of horses and mules. I understand that Dr. Koch is sanguine as to the result of his researches. Time alone will show whether his efforts or those of Dr. Edington and other labourers in this field have given us the much-to-be-wished-for certainty of rendering horses and mules immune from this disease. Work is being carried on in the investigation of the other manifold sicknesses to which animals are liable in South Africa, but 'science is slow,' and much more time and patient research are necessary before we can arrive at what we look forward to—a period when we shall no longer be helpless and at the mercy of these devastating pests."

Papers read before Section A.

The genesis of soils, with special reference to the Transvaal, by Mr. A. F. Crosse. The author pointed out that the bulk of the parent rocks are of small potential value as soil formers. Illustrative of these deductions, he instanced the well known poverty of granite soils, and in contrast gave as an example the fertile soils of the Marico and Rustenburg districts. In these districts, situated around the edge of the granite, are numerous intrusions of basic rock, of high agricultural potentialities—as a result, the soils formed therefrom are the richest in the country. Mr. Crosse is optimistic as regards the future of agriculture in the Transvaal. Given a fair proportion of the revenue obtained from the taxation of the industry devoted to the intelligent fostering of agriculture, he did not see why, with the aid of science, farming on a fairly large scale should not give a fair return to the agriculturist, and so maintain that most necessary class—the yeoman farmer.

The metallurgy of the Transvaal, by Mr. J. Williams, president of the section. The author said that the mining of gold, until very recently, had been conducted in a very primitive manner. The Plattner process, for a long time, was the only one which held the field, but it could only be used in conjunction with some method of concentration. It was, however, left to Mr. McArthur to show that cyanide could be used commercially for the extraction of gold. Mr. Williams then proceeded to give an outline of the modern process of extraction as used in the Transvaal.

Some practical observations on forestry, by Mr. D. S. Muldoon. The author gave a list of trees that grew well in the Transvaal, and were of high economic value. He also mentioned the advisability of planting trees along the railway lines; these trees would be of use in affording shelter to the locomotives, which could, therefore, maintain more steam, especially in high winds, and when the trees were full grown the railway would have its own supply of timber for sleepers, beams, &c. A knowledge of forestry should also be given in the State schools, and children encouraged to plant trees, shrubs, and plants around the waste places surrounding the school sites. The utility and value of trees indigenous to the country were also touched upon. The advisability of street tree-planting in the towns of the Transvaal was also pointed out, and the attention of the president was directed to the need for a Forestry Bill dealing with timber on Crown lands.

Duration and areas of heavy rainfalls, by Mr. D. C. Leitch. The author gave figures as found by observatories in England and America on the rates of rainfalls, quoted Prof. Talbot's formula, and gave some results obtained in the Transvaal. He quoted one instance where 4·86 inches of rain fell in one hour, whereas the heaviest rainfall in the British Isles does not exceed the rate of 1·8 inches per hour. The author mentioned that the recent Bloemfontein flood was said to be due to a rainfall of $2\frac{1}{4}$ inches over 14 square miles of catchment area.

Mr. G. A. Denny read a paper on diamond drilling and prospecting by drilling.

The prehistoric monuments of Rhodesia, by Mr. E. P. Mennell. The author discussed the question as to the origin of the larger of the various ruins which occurred in Rhodesia, depicting the possibility of the structures having been erected by indigenous tribes.

Nature-study in South Africa, by Mr. Sclater. The author pointed out the weakness of the type system of the study of biology. The love of nature should be fostered by the teacher taking children into the field. For example, in the case of birds, the child should be taught to note the times of migration, and inquire to what extent migrating birds nest in South Africa. They knew very little about the mammals of South Africa. They knew little about the life-history of frogs and toads. The habits of spiders opened up a large field for study. He urged that pupils should be encouraged to collect so as to form school museums.

The cyanide process from the standpoint of modern chemistry, by Dr. J. Moir. Dr. Moir described the solution, precipitation, &c., of gold on the line of the ionic theory, and showed that various reactions which had formerly been considered obscure could quite well be explained by it.

Some economic problems in metallurgy on the Witwatersrand, by Mr. Harry S. Denny. The author dealt with the salient features of metallurgical practice on the Witwatersrand from the point of preliminary breaking to the handling of slimes and sand residues.

The evolution of the treatment of by-products on the Witwatersrand, by Mr. M. Torrente. The author summarised the principal by-products produced in a mine as follows:—In connection with the battery: concentrates, black sands, sweepings, slags, pots, ashes, battery chips, and screenings. In connection with chlorination works: pots and ashes. In connection with cyanide works: concentrates, sands and slimes, slags, white slimes, Prussian blue, scrapings, sweepings, skimmings, dross, litharge, brick dust, test bottoms, sump sediments, ashes, crucibles and liners. The list is large, and if there is to be any profit, the cost of recovery must necessarily be less than 4*l.* a ton. Although, said the author, much has been attained, plenty of problems still await solution. On the Rand money is lavishly spent if there seems the remotest chance of effecting an improvement. The friendly rivalry, as well as the interchange of ideas and experiences, all help in the same way, and this is one of the most noticeable features of the scientific life of the Rand.

The chemical industry of the Transvaal: a forecast, by Mr. W. Cullen. The author remarked that on account of the gold industry being such a large factor in the prosperity of South Africa, they were sometimes inclined to overlook the possibilities of others. The chemical works and the dynamite industry managed to exist now with practically no protection, and this ought to make them look around. Proceeding, he outlined the existing chemical industries of the Transvaal the total making a very poor show. He included the cement works at Pretoria, which, he said, was now manufacturing an article equal to European brands. Looking ahead, he asserted that the term metallurgy, as used in the Transvaal, would soon have a much wider meaning than at present, and would embrace that of zinc, lead, copper, and possibly tin and iron. Foremost among the chemical imports was that of cyanide, and he was optimistic about the possibility of manufacturing it in the Transvaal at a profit. The plague, and the greater attention being paid to matters sanitary, had created a steady demand for chloride of lime, all the raw materials for which were to be found in the country. There would soon be a great demand for artificial manures, and here again nearly everything was at hand. Among other possible industries, he mentioned that of candles and oil from the shale which was abundant, alkali from by-products, glass, soap, alcoholic fermentation and distillation, when potatoes and mealies became cheaper, &c.

The contact process of sulphuric acid manufacture, by Mr. E. Weiskopf. Results of some further observations upon the rate of evaporation, by Mr. J. R. Sutton.

Papers read before Section B.

Biological and ethnological observations on a trip to the north-east Kalahari, by Dr. Schonland.

The geological features of the diamond mines in the Pretoria district, by Mr. Herbert Kynaston, director of the Geological Survey, and Mr. A. L. Hall. The authors, after describing briefly the area and situation of the Transvaal diamond fields, proceeded to give an account of the general geological structure of the district in which they occurred. The diamond pipes contributed a group situated on the high ground forming the watershed between the Elands and Pienaars Rivers, about 22 miles east of Pretoria. They have been intruded into the uppermost beds of the Pretoria series—a formation consisting of quartzites, shales, and diabase sheets, lying between the dolomite and the Waterberg sandstones—and are found to be surrounded partly by

quartzite and partly by intrusive sheets of diabase and felsite. Their situation is, in the authors' opinion, associated with lines of weakness which have been set up by the movements and dislocations which have affected the Pretoria series in the diamond field area. In the case of the Premier Mine, the pipe is almost entirely surrounded by a felsitic rock, which is intimately associated in places with a diabase. This diabase and felsite, in fact, pass gradually the one into the other, and form the lower and upper portions respectively of a large intrusive spot. The walls of the Premier pipe at lower levels, however, appear to consist of the quartzite which underlies this sheet.

Alien plants spontaneous in the Transvaal, by Mr. Joseph Burtt-Davy. The author dealt with the question, Where do our immigrant plants come from? An analysis shows that the regions where the immigrants are native are approximately as follows:—the Mediterranean region (*i.e.* the countries of south Europe, west Asia, and North Africa, immediately bordering the Mediterranean Sea), approximately 42 per cent.; tropical Asia, approximately 10 per cent.; tropical Africa, approximately 9 per cent.; tropical America, approximately 18 per cent.; northern Europe, approximately 7 per cent.; South Africa, approximately 6 per cent.; temperate North America, approximately 3 per cent.; Australia, approximately 3 per cent.; temperate South America, approximately 2 per cent.; Central Asia, approximately 1 per cent. The means by which plants migrate from country to country were then considered. The author said these fall under two heads:—(*a*) artificial means or by the agency of man; (*b*) natural means. The former methods are responsible for far the largest part of modern plant migration. They include (1) dispersal of roots and seeds by farm machinery; (2) conveyance of seeds and bulbs in the earth around the roots of nursery stock; (3) conveyance of seeds in the packing material of warehouse and shop goods; (4) conveyance in hay and other forage; (5) conveyance in impure samples of farm and garden seeds; (6) intentional introduction as useful or ornamental plants, subsequently escaping the garden or farm and becoming naturalised; (7) conveyance from port to port in the ballast of sailing vessels; (8) conveyance in railway trucks, which drop seeds at stations along the road; (9) conveyance by trek oxen and waggons, which drop them along the roadside; (10) conveyance along the tow-path; (11) conveyance by irrigation water.

The natural means are as follow:—(12) spreading by runners as in the tweekgranesk; (13) spreading by underground rhejoines, as in Johnson grass or evergreen millet; (14) spreading by running roots, as in the Canada thistle; (15) special structures of the cupule, enabling it to throw seeds for long distances; (16) the provision of flying apparatus attached to seeds, so that they are carried by the wind—one of the most common methods; (17) drifting by the wind over snow or frozen ground; (18) tumbleweeds; (19) conveyance by floods and streams; (20) burr-weeds, &c., carried in the hair and wool of animals, one of the most common contrivances for distribution; (21) seeds and pieces of plants carried on the feet of water-birds and aquatic reptiles; (22) kraal weeds, the seeds of which pass through animals undigested; (23) spiny fruits and branches carried by animals.

Trout acclimatisation in South Africa, by Mr. B. Bennion. Trout acclimatisation was dealt with generally, and the history of trout acclimatisation in South Africa—in Natal, Cape Colony, and the Transvaal—was given very fully.

The science of bacteriology and its commercial aspects, by Mr. W. H. Jollyman. The object of this paper is largely to answer the question, What practical results accrue from the study of the science of bacteriology? The reply is divided into four sections, showing (1) the assistance the science renders to medicine in the matter of diagnosis of disease; (2) the improved treatment, and consequent lessened mortality resulting from a knowledge of the causal agents; (3) the public health and sanitary science aspects of the study; (4) the work bacteria do in other than medical fields. Towards the end of the paper Mr. Jollyman said, the recent plague epidemic is testimony to the value of bacteriological work; what might have happened had not the early cases been examined bacteriologically one cannot tell, but it is quite certain that the value of an early diagnosis has been incalculable. With regard to the non-pathological side of the question, the remarks made about brewing, butter-making, sewage disposal, soil fertility, &c., will suffice to indicate the commercial value of scientific investigation into these branches. What is going to happen in the future as the result of the study of bacteriology it is impossible to foretell. On the medical side, men are endeavouring to find out more about the causes of human diseases, and to follow up these discoveries by the introduction of specific cures. Veterinary bacteriologists are doing the same work for animals.

In what may be called the bacteriology of the trades, there is no question that there is a great deal to be done; brewing, tobacco-curing, manufacture of organic chemicals—possibly glycerin—and soap manufacture may before long become bacterial work, and so on. In fact, the study of these, the smallest living things known, leads to results of the greatest commercial value.

The bacteriological and other aspects of miners' phthisis, by Dr. L. G. Irvine. The author mentioned the urgent matter of prevention of this disease, and, putting the question as to why the disease should be more prevalent on the Rand than in most other mining centres, he stated that this was due to three reasons. First, the rock was hard and the mines were dry; second, the number of rock-drills used was proportionately great; and third, the quantity of explosives used was also proportionately large.

Notes on some pathogenic bacteria as found in the Transvaal, and their variations from their European prototypes, by Mr. F. H. Joseph.

Papers read before Section C.

Survey practice in the Transvaal, by Mr. P. B. Osborn. The author traced the development of survey practice in the Transvaal from the time of the first crude subdivision of land by the Voortrekkers to the present systematised scientific methods.

Geodetic surveying, by Mr. W. H. Greathead. The author first defined geodetic surveying as the art of surveying extended to large tracts of the earth's surface, in which account must be taken of the curvature of the earth, and proceeded to describe the delicate apparatus and methods used in measuring base lines for the Natal and Cape Colony survey; also the apparatus for the Rhodesian survey.

The mine surveyor and his work on the Witwatersrand, by Mr. A. E. Payne. The present Government is preparing, said the author, to establish the mine surveyor as a professional man. The detailed knowledge of the great variety of subjects coming within the scope of his work is worthy of consideration. He should become the technical adviser of the mine and be encouraged to develop his work from the professional point of view of a mine surveyor.

Fire protection in the mines, by Mr. G. H. Thurston. The Rhodesian tick fever, by Dr. Theiler. Having first pointed out the necessity for preventing the disease by wide publication of the methods to be adopted and by legislation, the author proceeded to discuss the geographical distribution and history of the malady.

The bacterial purification of sewage, by Mr. F. S. Prentice. Some conditions respecting irrigation in the new colonies, by Mr. W. Reid Bell. The blizzard of June 9–12, 1902, by Mr. C. M. Stewart, secretary, Meteorological Committee of Cape Colony. Seldom has South Africa been visited by a snowstorm of such severity, duration, and so extensive as that which started approximately at 6 p.m. on the evening of June 9, 1902, and continued practically without intermission at many places until the morning of June 12. Judging from the barometric readings, this storm seems to have originated in an area of low pressure in the centre of the colony, while the pressure in the west and south was increasing rapidly.

Papers read before Section D.

The handling of young children, by Mr. P. A. Barnett. The author pointed out that by people who recognised no scientific basis for education there is a good deal of random criticism of the efforts made to use systematically the data provided by other sciences. We want more system—not less; though the science of education remains yet to be formulated.

A paper on special assessment was read by Mr. Stephen Court.

Drawing for young children, by Mr. E. B. Sargant. The author said it was well recognised at the present day that the old plan of beginning to teach drawing by making the children produce a series of straight lines tended to disgust young children with the subject for their whole school life. It was much easier to draw circles than straight lines, as appeared natural if the mechanism of the arm was considered. It was also better to begin with drawing rather than with writing, and to practise from the shoulder at first, then from the elbow, and finally from the wrist and fingers. This plan prevented the straining of the eyes at a time when short sight was likely to be produced very early. There was also a great deal to be said for beginning with the brush and colour rather than with the pencil or chalk. Mr. Sargant then proceeded to consider in detail the code of the Orange River Colony, which gave effect in drawing to these principles.

General Business.

At a council meeting of the association on April 4, Sir Charles Metcalfe, the president, alluded to the visit of the British Association to Johannesburg next year, and said he had been in frequent correspondence with members of the committee which had been appointed in England, including Sir Norman Lockyer and Prof. Dewar. Everything is now settled except the route, the fixing of which it has been considered better to postpone until nearer the date. There is also the question as to who should be president for the year, and though this has not been decided yet, there was no doubt there would be a very good president coming out for the meetings. The greatest man of science of the day, Lord Kelvin, who would be eighty-one years of age next year, was resolved to come. With regard to the status of members of the South African Association, they would naturally be entitled to attend all the meetings of the British Association. The proposal was that there should be three days' meetings at Cape Town and three days' meetings at Johannesburg, with shorter sessions at Durban, Kimberley, Bulawayo, and other places visited.

Sir Charles Metcalfe also referred to the arrangements to be made in connection with the visit of the British Association at the annual business meeting of the South African Association. Certain local papers will be read, and these will be chosen by the local committees of the places where meetings are held, so that those who come from distances may have the opportunity of hearing a good paper dealing with the chief object of interest in that particular centre.

THE NEW ZEALAND VEGETABLE CATERPILLAR.

FEW among the smaller natural productions of New Zealand have attracted more attention than the so-called vegetable caterpillar of New Zealand, of which we have just received a very fine specimen from Messrs. Armbrecht, Nelson and Co., of Duke Street, Grosvenor Square, W. Fungoid parasites are sufficiently common in all parts of the world, but are not generally conspicuous enough to be much noticed by any persons but naturalists. Many of the largest and most remarkable moths of the Australian region belong to the families Cossidæ and Hepialidæ, represented in Europe by our goat moth and swifts, and the caterpillars of several species of these are known to be infested by various parasitic fungi belonging to the genus Cordyceps, Fries, which convert the whole substance of the caterpillar into a woody substance, and then sprout from it to a length of several inches.

As in the case of larvæ attacked by insect parasites, these (which are usually about four inches long when full grown) live until they are ready to assume the pupa state, when they bury themselves in the ground, die, and the fungus sprouts upwards, generally from the neck of the caterpillar, sometimes acquiring the length of nearly a foot, and sprouting up from the ground above the caterpillar. Very rarely two, or even three, of these filaments may sprout from a single caterpillar. The best known species is *Cordyceps Hugelii*, Corda (*Sphaeria Robertsii*, Hooker), which is extremely abundant in New Zealand.

"The New Zealander's name for this plant-caterpillar is Hotete, Aweto, Weri, and Anuhe. The natives eat the plants, which when fresh have the flavour of a nut, and also use them, when burnt, as colouring matter for their tattooing, rubbing the powder into the wounds, in which state it has a strong animal smell" (Gray, "Notices of Insects that are Known to Form the Bases of Fungoid Parasites" (1858), p. 6, note quoting from Taylor). Almost every writer in New Zealand has discussed the vegetable caterpillar in more or less detail, notably Taylor and Hochstetter, in addition to Gray's important paper quoted above. Mr. G. Massee's "Revision of the Genus Cordyceps" (*Annals of Botany*, vol. ix. pp. 1–44, pls. i. and ii., March, 1895) may also be consulted.

It is probable that more than one species of New Zealand caterpillar is infested by, perhaps, more than one species of Cordyceps. *C. Hugelii* (*Robertsii*) is usually said to be parasitic on the larva of the large green moth *Hepialus* (*Œnetus*) *virescens*, Doubleday, but Mr. G. V. Hudson points out in his "New Zealand Moths and Butterflies" (p. 132) that this cannot be the case, because the larva of that insect burrows in the wood of trees, and forms its pupa in the galleries, and not in the ground. He suggests that it may infest the larva of *Porina Mairi*, Buller, a brown moth with black and white spots and markings; but this seems equally improbable, for this is a very rare moth, of which very little seems to be known. More information on these curious parasites and their hosts is very desirable.

W. F. KIRBY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A meeting of the University Junior Scientific Club was held on May 4. Mr. H. B. Hartley exhibited an unpublished portrait of Sir Richard Owen. Mr. A. S. MacNalty read a paper on William Harvey.

The eleventh Robert Boyle lecture will be delivered on June 3 in Balliol College Hall by Prof. J. J. Thomson, F.R.S. His subject will be "The Structure of the Atom."

The Romanes lecture will be delivered by Sir Courtenay Peregrine Ilbert, K.C.S.I., Balliol College, on Saturday, June 4, at 3 p.m., in the Sheldonian Theatre. The subject of his discourse will be "Montesquieu."

A meeting was held in the schools on Friday, May 6, to discuss the question of the organisation of post-graduate study. The president of Trinity was in the chair. The meeting was largely attended by those who are interested in the encouragement of research. Prof. Poulton moved a resolution advocating the expediency of "the further utilisation of fellowships for the purposes of research." This was seconded by Profs. Ellis and Gardner, and carried unanimously. Dr. Farnell moved a resolution favouring "the better organisation of the teaching resources of Oxford." He wished to see the boards of faculty take a more active part in organising the teaching resources, which now suffer from considerable dislocation. The boards ought to be able to give the status of professor to a college tutor, and assign him an income from university funds. The general principle of Dr. Farnell's resolution was carried.

CAMBRIDGE.—Sir Michael Foster has been re-appointed a manager of the Balfour (Animal Morphology) Fund.

Applications for leave to occupy the university tables at the Naples and Plymouth Zoological Stations are to be sent to Dr. Harmer, King's College, by May 26.

Mr. Frank G. Smart, M.B., has generously endowed a university studentship for research in botany of the value of 100*l*. a year for two years. The first election will be made in July.

The Board of Agricultural Studies reports the continued progress of the department, which last term had forty students. A number of field experiments have been instituted, and are in progress on the university farm and in the adjoining counties, under the supervision of Prof. Middleton and his staff.

THE Drapers' Company has decided to grant 15,500*l*. to the University College of South Wales for the purpose of erecting the structure of the proposed new library, in lieu of 10,000*l*. conditionally granted in 1895.

IT is announced in *Science* that at the recent Convocation of the University of Chicago, President Harper acknowledged a gift of 1000*l.* for special investigation in the department of physics, by the president of the board of trustees, Mr. Martin A. Ryerson, and a gift of 2000*l.* by Miss Helen Snow as a memorial to George W. Snow, her father, to rebuild the horizontal telescope at Yerkes Observatory, which was injured by fire.

AMONG the many educational enterprises of the Lancashire County Council, the system of technical instruction for fishermen, which is being much appreciated by the fishermen along the Lancashire coast, deserves special comment. The county council has arranged for batches of fifteen fishermen at a time to attend at the Piel (Barrow) Hatchery and Marine Laboratory to be instructed in the habits and conditions of breeding of various kinds of fish. The course lasts a fortnight, during which time the fishermen reside at Piel. The county council allows each man 5*l.* towards his expenses. We have received from Prof. W. A. Herdman, F.R.S., a copy of the syllabus of the lessons in marine biology given in these practical classes, and it shows that in addition to an introductory course, time is found for the fishermen to dissect and study the mussel, shrimp, crab, cockle, oyster, and fish parasites, and also to become acquainted with the leading facts about the breeding of these and other forms of life. Such courses of work as these must be of great value to fishermen.

IN his presidential address to the British Association last year, Sir Norman Lockyer used the two-power principle by which our naval expenditure is determined to illustrate and emphasise his appeal for State aid for universities equivalent to any two nations commercially competing with us. Recognising that universities are the chief producers of brain-power, and therefore the equivalents of battleships in relation to sea-power, examination was made of the provision for university education in Germany and the United States and that existing in this country. The result showed clearly that "instead of having universities equalling in number those of two of our chief competitors together, they are by no means equal to those of either of them singly." In connection with this comparison, it is of interest to notice that in answer to a question asked in the House of Commons last week, the average annual cost of maintaining in commission a first-class battleship of about 13,000 tons was stated to be, in round numbers, 94,000*l.* The State contribution to the whole of our universities and colleges amounts to about 156,000*l.* a year, that is, less than the sum required to keep two battleships in commission.

IN a dedication address at the opening of Palmer Hall, Colorado, Prof. S. Lawrence Bigelow dealt with the growth and function of the modern laboratory. The address is printed in *Science* of April 22. Eighty years ago, said Prof. Bigelow, there was not, in any country, a single laboratory for the purpose of teaching chemistry, though, of course, the subject had been taught for many years by means of lectures forming a recognised part of a medical course. To Liebig, at Giessen, belongs the credit of establishing the first chemical laboratory ever opened to students in a university. This was soon after 1824, the year in which he began his work at Giessen. So far as the foundation of laboratories in America is concerned, the address states that chemistry was taught in the laboratory in the medical department of Harvard University at an early date, and in 1846 a new medical school was built, the basement of which was devoted to a chemical laboratory capable of accommodating 138 students. At Yale Prof. B. Silliman and his son established a laboratory of analytical chemistry, and it became of sufficient importance to be incorporated as part of the university in 1847. The University of Michigan is generally recognised as being the first to introduce the laboratory method in teaching. A building exclusively for the teaching of chemistry was finished in this university at a cost of 1200*l.*, including the equipment, and was in use in 1856. But, as Prof. Bigelow remarked, it would be harder to find a university without moderately good laboratories to-day than it was to find one with them in 1850. The concluding sentences of the address will appeal to all men of science:—"Our laboratories have overwhelmingly justified their cost by their past history, and are justified in making greater demands than ever, by the importance of the functions which they fulfil. It is to be hoped that philanthropists will be still more liberal than they have been, and that the people will tax themselves more than they ever have, through their legislatures, to give to all schools, colleges and universities. Such money is the fire insurance and the life insurance of society as a whole, guaranteeing the maintenance of law and order, and the ability of the next generation to support the burden of advancing civilisation, when its turn comes."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 25.—"On the Compressibility of Solids." By J. Y. **Buchanan**, F.R.S.

The solids dealt with in this research are the metals platinum, gold, copper, aluminium, and magnesium. Their absolute linear compressibilities were directly determined at pressures of from 200–300 atmospheres at temperatures between 7° and 11° C. The determinations were made by the same method, and with the same instrument which the author used for the determination of the compressibility of glass in 1880 (Roy. Soc. Edin. *Trans.*, vol. xxxix. p. 589).

The instrument consists essentially of a powerful force pump and a tubular receiver to take the samples of metals to be experimented on. These must have the form of rod or wire. The steel tube which forms the receiver has a length of 75 inches and an internal diameter of 5/16 inch. It is closed at each end by thick glass tubes having a bore of between one and two millimetres. In the present investigation the metals were all used in the form of wire (No. 22 S.W.G.). Inside the steel tube they are supported in an axial position by an internal concentric tube, and their ends project into, and are visible through, the glass terminals. Each glass terminal is commanded by a microscope with micrometer eye-piece and standing on a substantial platform, altogether independent of the rest of the apparatus. When the wire is properly placed in the receiver and the microscopes are in position, the pressure is raised to the desired height, as indicated by the manometer, and the ends of the wire are observed and their positions with reference to the micrometers noted. The pressure is then carefully relieved, and a displacement of both ends is seen to take place and its amplitude is measured. The sum of the displacements of the ends, regard being had to their signs, gives the absolute expansion of the wire in the direction of its length, when the pressure on its surface is reduced by the observed amount, and consequently also the compression when the process is reversed. From this the linear compressibility is at once obtained. If the mass of the wire be isotropic, then its cubic compressibility is obtained by multiplying the linear compressibility by three. The wires used were all well annealed before the experiment, with the exception of the magnesium.

In order to bring the ends into a suitable position for observation with the microscopes, the length of the wire had to be between 75 and 75·5 inches. The actual length was measured exactly in each case, and it averaged 75·32 inches (1·913 metres).

The manometer which indicates the pressure in the instrument is simply a mercurial thermometer with a very thick bulb. The scale on it is an arbitrary one, and its value as a measure of pressure is fixed by observing its reading in comparison with the principal piezometer which was used by the author during the voyage of the *Challenger*. The standard of pressure is therefore an open-air column of sea-water of known properties. The micrometers in the eye-pieces of the microscopes were standardised by reference to a stage micrometer which was verified at the National Physical Laboratory. Their values were very nearly equal, with the powers used. One division in the eye-piece corresponded to 0·000422 and 0·000417 inch respectively on the stage, or to about 1/180000 of the length of the wire.

In the paper the results for each metal are given in a separate table. It will be sufficient to reproduce the summary, Table I. In it the compressibilities of English

flint glass and of the glass of which ordinary German tubing is made, as well as that of mercury, have been included for purposes of comparison. The compressibility of mercury rests upon a large number of observations made in the *Challenger* (Chem. Soc. *Journ.*, 1878, vol. xxxiii. p. 453).

Table I.—Summary.

Substance	Year	Atomic Weight	Density	Compressibility	
				Linear	Cubic
Platinum... ...	1904	194	21·5	0·1835	0·5505
Gold	,,	197	19·3	0·260	0·780
Copper	,,	63	8·9	0·288	0·864
Aluminium ...	,,	27	2·6	0·558	1·674
Magnesium ...	,,	24	1·75	1·054	3·162
Mercury	1875	200	13·6	1·33	3·99
Glass, flint ...	1880	—	—	0·973	2·92
,, ,, ...	1904	—	2·968	1·02	3·06
,, German	,,	—	2·494	0·846	2·54

It is pointed out that the number of metals experimented on is too small to permit any confident generalisation.

It will, however, be observed that in the case of the five metals used as wire, their compressibility increases as their density and atomic weight diminish, yet there is no reason to suppose that the compressibility is a continuous function of the atomic weight, like the specific heat. Mercury, although in the fused state, shows this clearly. But besides this, it happens that two pairs out of the five metals, namely, platinum-gold and aluminium-magnesium, are contiguous in the atomic weight series, yet the compressibility of magnesium is, roughly, double that of aluminium, and the compressibility of gold is half as much again as that of platinum. If, however, we compare gold and copper, which occupy parallel positions in Mendeléeff's scheme, we see that they are very much alike, and the same holds with regard to magnesium and mercury, which occupy a homologous position. If these facts indicate anything more general, we should expect the metals of the palladium and iron group to have a low compressibility like platinum, zinc and cadmium to have a very high compressibility like magnesium, and thallium an intermediate but still considerable compressibility like aluminium.

It will be observed that the two kinds of glass mentioned in Table I. are more compressible the greater their density. This may, however, be due to a specific feature of the oxide of lead which enters largely into the composition of the flint glass.

Referring to the use of glass exposed to high internal pressure, the author says:—In the work connected with this paper, which extended over the greater part of four weeks, fifteen glass terminals gave way, and oddly enough, the failures were as nearly as possible equally distributed between the two ends; eight of them fell to the left arm and seven of them to the right arm. The bursting of a terminal causes no inconvenience beyond the trouble of replacing it, because the construction of the instrument enables air to be completely excluded from it, and the quantity of water in it to be kept within such limits that its resilience is of no account. When a tube bursts it usually splits longitudinally up the middle into two slabs. One of these almost always remains entire; the other is sometimes broken into fragments, but there is never any projection of material unless the instrument has been carelessly put together and air admitted. The paper concludes with an account and an illustration of some curious *microseismic effects* produced on the wires by the explosion of the glass terminals.

Geological Society, April 13.—Dr. J. E. Marr, F.R.S., president, in the chair.—The discovery of human remains under the stalagmite-floor of Gough's Cavern, near Cheddar: H. N. **Davies**. Gough's Cavern opens at the base of the cliffs on the south of Cheddar Gorge. Human and animal remains have been discovered at different times. The principal deposits are a stalagmite-like travertine overlying cave-earth. When excavating part of a fissure running northward a human skeleton was discovered, associated with flakes, scrapers, and borers of flint, embedded in cave-earth. The remains of the skeleton excavated comprise the skull, the bones of an arm, a leg, and part of the pelvic girdle. The other bones were allowed to remain *in situ*, and may now be seen. The position of the skeleton was that which would have been assumed by a drowned man. Interment is unlikely, because of the shape of the fissure, which was choked up with débris and calcareous deposits. The stature of the man was 5 feet 5 inches; he was of muscular build, with prognathous jaws, a straight thigh, a platycnemic tibia, and a thick dolichocephalic skull. The animal remains found in the cave-earth of other parts of the cavern are those of mid- and late Pleistocene age, and this evidence, together with that derived from the position and character of the skeleton, and the workmanship of the flakes, points to a period towards the close of the Palæolithic or the opening of the Neolithic age.—History of volcanic action in the Phlegræan Fields: Prof. Giuseppe **De Lorenzo.** The author recognises three chief periods in the volcanic history of the district:—(1) The eruptions which took place under the sea during the Pleistocene period. Their surviving products can be grouped in two divisions. The older of these (*a*) is represented by the piperno and grey pipernoid tuffs of the Campania. These deposits consist of grey trachytic tuff, with scattered black scoriæ, and with a varying proportion of non-volcanic sediment. The vents whence they were ejected are now no longer to be traced. The author is disposed to regard the piperno as a trachytic lava with schlieren, the dark lenticles being made up of such minerals as augite, ægirine, and magnetite, while the lighter matrix is felspathic (anorthose) with a spherulitic structure and microliths of ægirine and augite. The second phase (*b*) of the first eruptive period is represented by ashes, lapilli, pumice, and sands, intercalated with marine shell-bearing clays and marls, and also with conglomerates and breccias. (2) Above the records of the first volcanic period lie those of the second—the yellow tuff, which forms the most characteristic of the volcanic formations of the Phlegræan Fields. It is a yellow, compact, well stratified aggregate of trachytic detritus, through which are scattered fragments of tuff and lava. Its average thickness exceeds 300 feet. It was a submarine accumulation. Owing to the uniformity of its lithological characters, this tuff has not furnished evidence of a definite order of succession in the eruptions to which it was due. It is possible to recognise vents from which the tuff was discharged. (3) After the discharge of the yellow tuff the volcanic tract appears to have been upraised into land, and to have been exposed to a period of subaërial denudation. Vents made their appearance and discharged fragmental materials, differing from the tuff in showing a greater variety of composition, and in the proofs which they furnish of a succession of eruptions, and a gradual southward shifting and diminution of the eruptive energy. The largest and most ancient of the volcanoes of this latest period is that of Agnano. Not improbably it was from this eruptive centre that the trachy-andesitic lava of Caprara issued. The crater-lake of Avernus belongs to the latest group, and perhaps it was the water percolating from this basin to the thermal springs of Tripergole which, in September, 1538, gave rise to the explosion that built up Monte Nuovo—the youngest of the cones of the Phlegræan Fields.

Entomological Society, April 20.—Dr. F. A. Dixey, vice-president, in the chair.—Mr. M. **Jacoby** exhibited a ♂ specimen of the beetle *Sagra senegalensis* with ♀ characters, received from Mr. Barker in Natal.—Dr. Norman **Joy** exhibited *Orochares angustata*, Ev., taken at Bradfield, Berks., in December, 1903—the second recorded British specimen; a species of Tychius, which he said might be a variety of *Tychius polylineatus*, Germ. (not now included in the British list), or, more probably, a new species closely allied to it, taken near Streatley, Berks., last year; and two specimens of *Pselaphus dresdensis*, Herbst., taken near Newbury this year.—Mr. C. O. **Waterhouse** exhibited an unnamed species of Nemoptera from Asia Minor, resembling *Nemoptera huttii* from Australia.—Mr. F. **Enock**

read a paper on nature's protection of insect life, illustrated by colour photography, and exhibited a number of lantern slides.—Mr. P. I. **Lathy** communicated a paper on new species of South American Erycinidæ.—Major Neville **Manders,** R.A.M.C., communicated some breeding experiments on *Catopsilia pyranthi,* and notes on the migration of butterflies in Ceylon.—A discussion followed on specimens of the dipterous families Stratiomyidæ to Crytidæ, opened by Mr. G. H. **Verrall,** who said the object of the discussion was to determine the number and distribution of the British species comprised in these families. Colonel J. W. Yerbury said that on behalf of Prof. Poulton he had been asked to exhibit some specimens the interest of which mainly lay in the specific names used, which names were useful as showing the nomenclature employed by a past school of dipterologists, and might give a clue to the manner in which some reputed species have found their way into the British list. He directed special attention to *Ephippiomyia ephippium,* an insect reputed to have been taken at Combe and Darenth Woods, but which was without doubt of German origin; *Isopogon brevirostris,* probably the identical specimen referred to in Curtis's "British Entomology" as having been taken on The Devil's Ditch, Newmarket; and *Laphria marginata,* stated to have been bred from a hornet's nest. Mr. Colbran J. Wainwright, exhibiting two specimens of Anthrax, said that hitherto Mr. Verrall had believed that we had lost two certain species of Anthrax in this country, *A. fenestratus* and *A. paniscus.* His two specimens, though allied to *A. paniscus,* were abundantly distinct. One had been taken by Mr. R. C. Bradley at Bournemouth, the other by Mr. W. G. Blatch at Poole, but at present no name could be given to the species.

Chemical Society, April 20.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The following papers were read:—The vapour density of hydrazine hydrate: A. **Scott.** The author finds that at 98°·8 the vapour density is 15·8 instead of 25 as required by N_2H_6O; at 138° the dissociation into $N_2H_4+H_2O$ is complete, and at higher temperatures a certain amount of decomposition into nitrogen, ammonia and water occurs.—The combining volumes of carbon monoxide and oxygen: A. **Scott.** The results of the author's experiments indicate that the molecular concentration of carbon monoxide is slightly greater than that of oxygen, the combining volumes being CO : O : : 1·9985 : 1 with carbon monoxide from calcium oxalate, and 1·9994 : 1 with that from formic acid.—A revision of the atomic weight of rubidium: E. H. **Archibald.** The mean values of the atomic weight of rubidium obtained from fourteen analyses were 85·490 and 85·484 from the ratios AgCl : RbCl and Ag : RbCl respectively. Analyses of rubidium bromide led to the value 85·483, obtained from either of the ratios AgBr : RbBr or Ag : RbBr.—Experiments on the synthesis of the terpenes, part i., synthesis of inactive terpineol, dipentene and terpin hydrate: W. H. **Perkin,** jun. Pentane-$\alpha\gamma\epsilon$-tricarboxylic acid, when digested with acetic anhydride and subsequently distilled, is converted into δ-ketohexahydrobenzoic acid. The ester of this acid reacts readily with magnesium methyl iodide, yielding *cis*-δ-hydroxyhexahydro-*p*-toluic acid, which with fuming aqueous hydrobromic acid is converted into δ-bromohexahydro-*p*-toluic acid, which in turn yields Δ^3-tetrahydro-*p*-toluic acid when heated with pyridine and sodium carbonate. The ester of the latter with an excess of magnesium methyl iodide yields terpineol. From the synthetic terpineol so obtained dipentene and terpin hydrate were readily prepared in the normal manner.—A lævorotatory modification of quercitol: F. B. **Power** and F. **Tutin.** The lævorotatory modification described by the authors was obtained from the leaves of *Gymnema sylvestre,* a plant belonging to the family Asclepiadaceæ, and indigenous to Banda and the Deccan Peninsula.—The constituents of the essential oil of Californian laurel: F. B. **Power** and F. H. **Lees.** The Californian laurel, *Umbellularia californica,* yields an essential oil with a pale yellow colour and an odour at once aromatic and irritant. It was found to contain eugenol, *l*-pinene, cineol, safrole, eugenol methyl ether, veratric acid, and a new, unsaturated, cyclic ketone, *umbellulone,* $C_{10}H_{14}O$. To the last of these the peculiar pungency of the oil is due.—Some derivatives of umbellulone: F. H. **Lees.** A description of derivatives of umbellulone.—Ammoniacal double chromates and molybdates: S. H. C. **Briggs.** The compounds

$$CuCrO_4,3\tfrac{1}{2}NH_3,\tfrac{1}{2}H_2O;\ CuMoO_4,2NH_3,H_2O;\ CuWO_4,4NH_3\ \text{and}\ ZnWO_4,4NH_3,3H_2O$$

have been prepared and are described in the paper.—The hexahydrated double chromates. Magnesium and nickel compounds: S. H. C. **Briggs.**—Bornylcarbimide: M. O. **Forster** and H. M. **Attwell.** A description of this and related substances.—Reduced silicates: C. **Simmonds.** The substance left when lead silicates are reduced by heating in hydrogen is shown to be a compound which can be regarded as a combination of the metal and silica, in the same sense as the original silicate is a combination of the metallic oxide and silica. Similar results were obtained with the silicates of copper, iron, nickel and cobalt.—Picryl derivatives of urethane and thiourethane: J. C. **Crocker** and F. H. **Lowe.** The authors show that the reaction between picryl chloride, thiocyanates and alcohols is due to the formation of the ψ-thiourethanes of the type PiN : C(SH).OX as intermediate products, which subsequently react with picryl chloride and pass into the picriminothiocarbonates PiN : C(SPi).OX.—The oxime of mesoxamide and some allied compounds, part iii., tetrasubstituted derivatives: M. A. **Whiteley.** A description of a number of these compounds is given.

Royal Microscopical Society, April 20.—Dr. Hy Woodward, F.R.S., vice-president, in the chair.—A large tank microscope, made by Thomas Ross, presented to the society by the committee of the Quekett Microscopical Club, was exhibited. It was made not later than the year 1870, and was designed for the purpose of examining objects contained in aquaria.—The annual exhibition of pond life was given this evening by fellows of the society, assisted by members of the Quekett Microscopical Club.

Paris.

Academy of Sciences, May 2.—M. Mascart in the chair.—The action of terrestrial magnetism upon a tube of nickel steel (invar) intended for use as a geodesic pendulum: G. **Lippman.** The alloy of nickel and iron known as *invar,* which possesses a coefficient of expansion only one-twentieth that of brass, has obvious advantages for pendulum observations. This steel, however, is magnetic, and it was thought possible that the disturbing influence introduced in this way might be too large to be neglected. The magnetic moment of a tube of this material was determined, and the possible error on a pendulum observation calculated. It was found to be negligible, and hence invar can be advantageously substituted for brass in the pendulum.—The effect of small oscillations of the external action on systems affected with hysteresis and viscosity: P. **Duhem.**—Geodesic and magnetic work in the neighbourhood of Tananarive: P. **Colin.**—Polyvalent antipoison serums. The measurement of their activity: A. **Calmette.** The antihæmolytic power is a measure of the antitoxic power of a serum, and a method is described by which the former can be determined in glass.—Observations of the Brooks comet (1904 *a*) made with the bent equatorial at the Observatory of Lyons: J. **Guillaume.**—On a new apparatus for measuring the power of motors: Ch. **Renard.** The axle of the motor is connected to a bar carrying two aluminium vanes, the latter being capable of adjustment as regards their distance from the axis. This having been previously calibrated against a dynamometer, the determination of the horse-power of a motor is reduced to the determination of the angular velocity.—The Adolphe bridge at Luxembourg (1899–1903): M. **Séjourné.**—On the comparison of spectro-photometric determinations: P. **Vaillant.**—The sensibility of the azimuth balance: V. **Crémieu.** An extension of the theory of the azimuth balance, a description of which has been given in an earlier paper.—On the *rôle* of the centrifugal force component in the determination of the sense of rotation of cyclones and water vortices: Bernard **Brunhes.**—On the electrolytic solution of platinum. A new method for preparing platinocyanides: André **Brochet** and Joseph **Petit.** When platinum is used as the anode in a solution of potassium cyanide, it remains unattacked. With an alternating current the platinum is readily attacked, a

current density of 20 to 80 amperes per square decimeter dissolving from 0·4 to 0·6 gram per ampere hour. With barium cyanide, barium platinocyanide is formed by the action of the alternating current; the yield of the platinocyanide is good.—The origin of the Blondlot rays given off during chemical reactions: Albert **Colson.** Chemical reactions in which Blondlot rays are given off are always accompanied by physical actions, such as contraction or cooling.—On cacodylic acid and amphoteric bodies: P.-Th. **Muller** and Ed. **Bauer.** Different physicochemical methods all lead to the same conclusion, that cacodylic acid and its sodium salt have the same constitution; it follows that an amphoteric body is not necessarily a pseudo-acid.—The reduction of silica by hydrogen: A. **Dufour.** Silica is reduced at a high temperature by hydrogen, water and hydrogen silicide being formed. The inverse reaction is possible. This reduction explains the phenomenon of devitrification of silica tubes when heated in the blowpipe, and also gives a satisfactory explanation of the experiments of Boussingault and of Schutzenberger on the formation of the silicide of platinum by silica at a distance in a current of hydrogen.—On the zinc aluminium alloys: Hector **Pécheux.** By treating zinc with aluminium in various proportions, nine different well defined alloys have been obtained, the physical and chemical properties of which are described.—The action of diazobenzene chloride upon diphenylamine: Léo **Vignon** and A. **Simonet.** Phenyldiazoamidobenzene is obtained in this reaction.—On allyl and propenyl-alkyl ketones: E. E. **Blaise.**—The application of the Grignard reaction to the halogen esters of tertiary alcohols: L. **Bouveault.** By carefully regulating the temperature the chloride of tertiary butyl alcohol reacts normally with magnesium; the product absorbs carbon dioxide, giving pivalic acid. The reaction with ethyl formate was also studied.—On the symmetrical dichloromethyl ether: Marcel **Descudé.** Trichloride of phosphorus and polyoxymethylene react on heating in the presence of a little zinc chloride, giving a good yield of the above substance.—On a method of isolating cytoplasmic substances: Maurice **Nicloux.**—New researches on aucubine: Em. **Bourquelot** and H. **Hérissey.**—Abnormal hybrids: C. **Viguier.**—On the biology of *Sterigmatocystis versicolor*: Henri **Coupin** and Jean **Friedel.**—A food substance obtained from the pith of the Madagascar palm: R. **Gallerand.** The flour made from this palm is distinguished by its richness in albumenoid matter, of which it contains 10·5 per cent.—On the presence of tin in the department of Lozère: Marcel **Guédras.**—Nervous oscillations studied by means of the *n*-rays emitted by the nerve: Augustin **Charpentier.**—The modifications undergone by the digestive apparatus under the influence of diet: Camille **Spiess.**

DIARY OF SOCIETIES.

THURSDAY, May 12.

Institution of Electrical Engineers, at 8.—If the discussion on Messrs. Merz and McLellan's paper is concluded at the meeting of May 5, Messrs. Parsons, Stoney and Martin's paper on the Steam Turbine as applied to Electrical Engineering will be read and discussed.

Mathematical Society, at 5.30.—Some Mathematical Instruments: C. Cooke (communicated by Major P. A. MacMahon).—On the Evaluation of Certain Definite Integrals by Means of Gamma Functions: A. L. Dixon.—Generalisations of Legendre's Formula

$$KE'-(K-E)K'=\tfrac{1}{2}\pi:$$

A. L. Dixon.—Note on the Integration of Linear Differential Equations: Dr. H. F. Baker.—On Perpetuant Syzygies: A. Young and P. W. Wood.

Society of Arts, at 4.30.—British Grown Tea: A. G. Stanton.

FRIDAY, May 13.

Royal Astronomical Society, at 5.—Milky Way Charts of the Heavens to Argelander's Scale 1°=20mm., with description by H. Dennis Taylor and Alfred Taylor of the Lenses and Mount: J. Franklin-Adams.—Methods of Correcting Moon's Tabular Longitude: P. H. Cowell.—The Definitive Places of the Standard Stars for the Northern Zones of the Astronomische Gesellschaft: A. M. W. Downing.—Note on the Formulæ connecting "Standard Coordinates" with Right Ascension and Declination: F. W. Dyson.—*Probable Paper*.—On the Pivot Errors of the Radcliffe Transit-Circle: A. A. Rambaut.—On the new Greenwich Micrometer for Measurement of Photographs of Eros: Communicated by the Astronomer Royal.—Further Analyses of the Moon's Errors with the Mean Elongation as Argument: P. H. Cowell.

Malacological Society, at 8.—List of Mollusca collected during the Commission of H.M.S. *Waterwitch* in the China Seas, 1900–1903, with Descriptions of New Species: Surgeon K. Hurlstone Jones, R.N., and H. B. Preston.—On a Carboniferous Nautiloid from the Isle of Man: G. C. Crick.—Notes on the Genus Anoma: E. R. Sykes.—New Land Shells from New Zealand: Henry Suter.

MONDAY, May 16.

Sociological Society at 5.—Eugenics; its Definition, Scope and Aims: Francis Galton, F.R.S.

Royal Geographical Society, at 3.—Anniversary Meeting: Address by the President.

TUESDAY, May 17.

Royal Institution, at 5.—Meteorites: L. Fletcher, F.R.S.

Zoological Society, at 8.30.—On some Nudibranchs from East Africa and Zanzibar. Part v.: Sir Charles Eliot.—Description of a new Tree-Frog of the Genus Hyla, from British Guiana, carrying Eggs on the Back: G. A. Boulenger, F.R.S.—Notes upon the Anatomy of certain Boidæ: F. E. Beddard, F.R.S.

Royal Statistical Society, at 5.—Local Expenditure and Local Indebtedness in England and Wales: R. J. Thompson.

Society of Arts, at 8.—Pewter and the Revival of its Use: Lasenby Liberty.

WEDNESDAY, May 18.

Royal Microscopical Society, at 8.—Note on Grayson's Rulings: E. M. Nelson.—Exhibition of Flower Seeds under Microscopes: C. Beck.

Chemical Society, at 5.30.—Action of Nitrosyl Chloride on Pinene: W. A. Tilden.—The Electrolytic Estimation of Minute Quantities of Arsenic: H. J. S. Sand and J. E. Hackford.—The Decomposition of the Alkylureas (a Preliminary Note): C. E. Fawsitt.—The Action of Sodium Methoxide and its Homologues on Benzophenone Chloride and Benzal Chloride. Part ii: J. E. Mackenzie and A. F. Joseph.—The Formation of Periodides in Nitrobenzene Solution, II. Periodides of the Alkali and Alkaline Earth Metals: H. M. Dawson and Miss E. E. Goodson.

THURSDAY, May 19.

Royal Society, at 4.30.—The Bakerian Lecture will be delivered by Prof. E. Rutherford, F.R.S., on the Succession of Changes in Radio-active Bodies.—The following papers will probably be read in title only:—On Saturated Solutions: Earl of Berkeley.—On the Liquefied Hydrides of Phosphorus, Sulphur, and the Halogens, as Conducting Solvents. Part i.: B. D. Steele and D. McIntosh. Part ii.: D. McIntosh and E. H. Archibald.—On the General Theory of Integration: Dr. W. H. Young.

Institution of Mining and Metallurgy, at 8.—Miners' Phthisis—its Causes and Prevention: Dr. J. S. Haldane and R. A. Thomas.

Institution of Electrical Engineers, at 8.—Discussion on Messrs. Parsons, Stoney and Martin's paper, entitled The Steam Turbine as applied to Electrical Engineering.

FRIDAY, May 20.

Royal Institution, at 9.—The Radiation and Emanation from Radium: Prof. E. Rutherford, F.R.S.

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THURSDAY, MAY 19, 1904.

THE STRUCTURE OF AUSTRIA-HUNGARY.

Bau und Bild Österreichs. By Carl Diener, Rudolf Hoernes, Franz E. Suess, and Victor Uhlig. Pp. xxiv+1110. (Vienna: F. Tempsky; Leipzig: G. Freytag, 1903.) Price 78 kronen, or 65 marks.

THE publication of this elaborate and serious work implies a high regard for scientific education in the countries for which it is immediately intended. It is not a popular correlation of the scenic and geological features of the Austro-Hungarian Empire, such as would appeal to the ordinary traveller; and yet, now that it has appeared, we feel that no one can properly understand the regions dealt with until he has consulted this treatise, and thus brought himself abreast with current views. We recently had occasion to notice (NATURE, vol. lxviii. p. 550) the admirable series of brochures prepared in Vienna for the Geological Congress of 1903. The Bosnian guide then foreshadowed has since appeared, and sums up a surprising amount of recent observations made in the occupied provinces. But these publications do not detract from the value of the great work now before us, which is essentially a book for the library, clear, readable, and stimulating. Its reviews of successive opinions on this or that controverted area are of considerable mental value, and the authors state their own conclusions with a display of argument and reasoning that is rare in works of reference. As in a good deal of Austrian writing, the human man, scaling the hillside, or watching the great rivers swirling through the plains, is apparent through the topographical and geological details; and even the pages on petrography, when thus led up to, have an impression of the open air.

Prof. Eduard Suess contributes an introduction, in which he relates the growth of geological observation in the empire, from the mining operations of the sixteenth century to Partsch and Haidinger in 1850. The Bohemian region is then dealt with by Franz E. Suess in 322 pages, accompanied by landscape-illustrations that convey much of the character of the country. We thus see the white quarry on the Schlossberg of Brüx, the pastures of Eisenstein under the forest-rim, and one of the great black open workings of the brown-coal area in the north. The author shows well how the Bohemian region spreads beyond political Bohemia, and that, while watersheds divide nations, the boundaries of hill and plain define geological areas. If we reach Eisenstein, for example, we must go forward and make the plunge through the Bavarian forest to the Danube; on the other hand, the easy undulating country beyond Habern leads us inevitably to inquire into the structure of Moravia. While the great Bohemian "horst" is part of a range that arose during the movements of Middle Carboniferous times, its fundamental rocks are largely pre-Cambrian. The central granites have penetrated these gneisses and phyllites at a period which may be later (p. 56) than the Ordovician, and have profoundly modified and intermingled with the gneisses. The schists, on the other hand, possibly through their having been nearer the surface at the time of the intrusion, show a fairly sharp line of contact. Similar phyllites appear in Moravia in the cores of gneissic anticlinals, reversing the usual relations of such masses. Unless thrust-planes can be called in, it is clear that this region offers much room for speculation. Dr. F. E. Suess (p. 76) urges that considerable movements took place in Moravia before the great bow of old rocks, stretching from the Sudetic to central France, was folded and upheaved in the Carboniferous period. This is rendered likely by the antiquity of the rocks themselves, and is supported by the occurrence (p. 114) of pebbles of the early gneisses and amphibolites in pre-Cambrian conglomerates near Příbram.

The famous question of Barrande's "colonies" is dealt with historically and succinctly (p. 141). Among other interesting details, we can only refer to the evidence for the existence of central European deserts in Permian times; to the almost complete absence of marine Mesozoic deposits from Bohemia until the entry of the amazingly world-wide Cenomanian sea (p. 166); and to the comparatively recent origin of some of the ore-deposits in the Erzgebirge (p. 243). An excellent coloured map concludes this section.

Dr. C. Diener then enters on his difficult task of describing the Eastern Alps and the Dinaric Karst. He traces the central zone from the Swiss border, until it breaks off against the incurving areas of subsidence on the fringe of the Pannonian plain. The gneissic axis of northern Styria alone survives, and connects the Alps below Vienna with the Karpathians. While the author's debt to Prof. E. Suess is manifest and acknowledged, he feels bound to join those critics who regard the Alps as resulting from lateral thrusts in two opposite directions, instead of from a one-sided action (pp. 637 and 641). He is unable to recognise, either from the lie of the folds or from the curve of the whole chain, the outer from the inner side of a mountain system. The Dinaric folds thus present their concave side to the Servian mass against which they have been pressed, while the area of subsidence occupied by the Adriatic lies on the concave side of the Alps and on the convex side of the Dinaric system. Very many geologists will agree with Dr. Diener when he says of the southern Alps,

> "Hebung, nicht Senkung, ist also hier der Effekt der Zusammenfaltung gewesen. Eine wirkliche Senkung hat nur bei dem jüngeren Einbruch des Adrialandes stattgefunden" (p. 638).

The remarkably late origin of the Adriatic subsidence is emphasised on pp. 607 and 629, the alluvial sands of southern Istria being probably involved, and the movements being certainly post-Pliocene. The Alps, on the other hand, are regarded as having remained stationary at this epoch, in opposition to the views of Dr. Heim.

The island-like masses of folded rocks that rise, as a welcome feature, above the lower Sava plain are once more regarded as the partially buried spurs of the eastern Alps (p. 566), and not as portions of an older system. Dr. Diener finds himself also opposed to the torsional views of Mrs. Ogilvie-Gordon in re-

gard to the huge blocks of dolomite in Tyrol (p. 548), and believes that these weighty masses have sunk down amid the yielding tuffs and sediments deposited upon their flanks. The reef problem is dealt with cautiously (p. 541, &c.), and the term "reef" is used, following Prof. Suess, as the equivalent of "massive unstratified limestones and dolomites," rising amid strikingly contrasted sediments. It is unfortunate that the latest evidence brought forward by Mrs. Ogilvie-Gordon as to the age of the igneous intrusions round Predazzo was published too recently to receive adequate notice in this volume, though her arguments and those of Rothpletz are briefly mentioned.

For those who desire a general history of the Alps, adorned with modern references, we may commend the whole seventh "Abschnitt" (pp. 589–610) as a clear and even spirited summary. The discussion of mountain-structure that follows shows the independence and vitality of the school which Suess has founded in Vienna, a school of progressive inquiry unhampered by dogmas, active in unearthing problems, but willing to wait for explanations.

Dr. V. Uhlig is given 260 pages for the exposition of the Karpathian lands, and occupies them with admirable clearness. Like his predecessor, he balances arguments, and states his own conclusions with the modesty of a true explorer. This is particularly noticeable (p. 904, &c.) in his account of the origin of the central *massif* of the Karpathians, which he regards as pushed up by pressure from all sides into and partly through its former Mesozoic covering. One-sided tangential movement will not, in his opinion, in any way satisfy the facts observed (p. 910).

The illustrations and sections accompanying Dr. Uhlig's descriptions are more than usually attractive. We see patches of Eocene conglomerate resting on the central granite of the Tatra, and crystalline schists, on the other hand, thrust up over Neocomian limestone at Bárat Lehota, and sending off dyke-like tongues into the cracks opened in the latter. The fascinating question of the "Klippenzone," referred to by us in a previous review, receives full treatment. The beautiful landscape on p. 771 recalls many of the deep wooded valleys, among sheer limestone cones, which intersect the frontier lands of Arva. The tempting theory that the "Klippen" float as detached fault-blocks amid the softer Flysch deposits is set aside (pp. 791–4), in face of the banks of Upper Cretaceous conglomerate worn from them, and found so repeatedly against their flanks. Examples of these occur from the west end of the chain down to Transylvania (p. 809).

The great Flysch or Karpathian Sandstone series has yielded foraminifera in places, but is otherwise singularly devoid of organisms. Zuber has aptly compared it with the huge delta deposits of the Orinoco. Rock-salt and mineral oil characterise the Miocene horizons in Galicia, and Dr. Uhlig (p. 864) accepts an unconformity between these and the Karpathian Sandstone. He then shows how the present broken condition of the salt-beds may be due to post-Miocene earth-movements.

The important volcanic zone on the inner side of the mountain-ring raises again (p. 879) the question of the relations of the igneous rocks at Selmeczbánya. Prof. J. W. (not "C. W.") Judd is quoted, and the existence of a great central volcano is left as a possible solution. It is pleasant to find a photograph of the lofty obsidian cliff of Geletnek among others of this picturesque area. The rich ore-deposits of northern Hungary occupy cracks in the Miocene lavas, and are among the latest manifestations of the solfatara stage of the eruptions. While the Mesozoic rocks of the Karpathians were folded in early Eocene times, the volcanic outbreak can only be connected with the slighter post-Miocene movements, and appears to have accompanied the general sinking of the lowland.

We cannot do full justice, in concluding this notice, to Dr. Rudolf Hoernes's section on the plains. The Cainozoic history of the empire is involved in that of these great wind-swept level lands. We are taken from the basin of Vienna, which is really an area of depression formed within the body of the Alps, to the sandy reaches on the edge of the Government of Warsaw, where soil and vegetation have difficulty in clinging to the surface (p. 1049). The salt-beds of Wieliczka (p. 942) again come in for treatment, since the separate publication of the four divisions of the volume renders some overlapping unavoidable.

The ravine of the Danube east of Passau, already touched on picturesquely by Dr. F. E. Suess (p. 105), receives full discussion here after an interval of a thousand pages. Following Penck, the general conclusion is that the Danube flowed in pre-Glacial times over the detrital deposits of late Cainozoic age, cutting broad valleys in these, and ravines where it reached down to the underlying ancient rocks. The present prominence of the latter rocks is due to the denudation of the more yielding Cainozoic strata.

Of the four authors, Dr. F. E. Suess perhaps best realises the landscapes in his word-pictures; but the whole book has a literary value, and is thus all the more competent to stimulate observation and research. Its modernised spelling, such as "Zentralkern" and "Gneise," is perhaps a sign of its virility. The absence of an index will surely soon be rectified.

GRENVILLE A. J. COLE.

A NEW FRENCH TREATISE ON CHEMISTRY.

Traité de Chimie Minérale. Published under the direction of Henri Moissan, with many collaborators. Tome Premier—Métalloïdes; Tome Troisième—Métaux. Pp. xiii+527 and 672. (Paris: Masson et Cie., 1904.) Price 125 francs net.

THE recent advance in inorganic chemistry, to which M. Moissan has in no small degree contributed, has rendered it advisable, in his opinion and in that of his co-workers, to take stock, so that those engaged in research in that branch of chemistry may have in an accessible form an account of the whole field and a full bibliography of published memoirs. It is the laudable ambition of the editor to point out what gaps still remain unfilled, and where research may most profitably be undertaken. The atomic theory is

assumed as a basis of method, but in his preface M. Moissan says :—

"Nous apportons, sur ce sujet, des idées éclectiques, et la raison, éclairée par l'expérience, sera toujours notre seul guide."

The geological and mineralogical sources of substances are considered, but the details of physical and analytical chemistry are not touched. Industrial operations are sometimes chosen to illustrate chemical change, and, where thought desirable, the prices and tables of production of different countries are introduced. The work is primarily intended for those engaged in research, in industry, and in teaching. Among the thirty-two contributors may be mentioned the names of Charpy, Étard, Le Chatelier, Lemoine, Sabatier, and Vogt, besides many others of good reputation.

The introduction by the editor gives a historical sketch of the classification of the elements. In the present state of our knowledge of elementary bodies it is interesting to meet with the unprejudiced words of Lavoisier :—

"If, by the word element, we mean the simple and indivisible molecules of which bodies are composed, it is probable that we do not know them; but if, on the other hand, we apply the name element or principle to the last term at which chemical analysis arrives, all substances which have not hitherto been decomposed are for us elements."

The bearing of spectrum analysis on the question of the unity of matter is briefly touched on, and Moissan says that in his own high temperature work no sign of transmutation has ever been observed. He inclines, however, to the supposition of the unity of matter, and in alluding to the recent work connected with radio-activity, he believes that "we are witnessing the dawn of inorganic chemistry, a subject not long ago regarded as exhausted."

Various attempts at classification are next considered, but not even the periodic table is adopted. The reviewer cannot agree that the method followed presents any advantage whatever. The first family comprises hydrogen and helium, and the reason given for this curious collocation of elements is that helium is not well known! Carbon is separated from silicon, because the latter element forms no large number of "organic" compounds, and because the halides of silicon, like those of titanium and zirconium, are decomposed by water. While in most groups the element of lowest atomic weight is discussed first, cæsium begins the metals of the alkali group, because of its chemical activity; for the same reason the nitrogen group should begin with phosphorus. The final statement that the author thought it better to group the elements in accordance with their known properties rather than to give them to the reader in the disorder of alphabetical order seems hardly a happy way of determining which method of classification is the best, seeing that no particular properties are chosen, the criterion of resemblance sometimes being the appearance of the element, sometimes its melting-point, sometimes the stability of its salts in presence of water, and sometimes none of these, as where cobalt is placed in the same group as uranium, and lead and tin are separated from each other.

The result is, that without an index, which has not yet appeared in any one of the published parts, it is an almost hopeless task to find any desired compound. Gmelin's plan, perhaps, may serve as guide, that is, to find out the elements which have been treated of already, and to take the last in the formula of the compound as an index. But this leads to such an anomaly as having to look up bismuth thiocarbonate under "carbon," while potassium thiocarbonate comes under the heading "potassium." The amido-derivatives, too, are to be found after the salts from which they are prepared, and do not form a group by themselves, similar as they all are to each other.

Subject to these criticisms, however, the work is very complete, and is a most valuable compilation. It is unfortunately not free from omissions; for example, in discussing the determinations of the density of hydrogen, the work of Lord Rayleigh has been overlooked. Again, it is stated on the authority of Lunge (1879) that the greatest amount of chlorine in the world is made at the St. Rollox Works in Glasgow, a statement which is now unfortunately inaccurate. The spelling of proper names, also, leaves room for correction; Brareton-Baker, Tadeusz Estreicher, and Stass are among those which have caught the reviewer's eye. But, as before remarked, the index of literature is very large, and the number of facts given is greater than what is ordinarily to be found in a text-book, while the information is generally up to date, and these are advantages which cannot be overlooked.

ELECTRIC TRAMS.

Electric Traction. By J. H. Rider. Pp. xvi+453. (London: Whittaker and Co., 1903.)

THE name of the author and his position as chief electrical engineer to the London County Council Tramways are sufficient to recommend this book to anyone interested in electric traction. Nor do we think that anyone who takes it up in the hope of gleaning some useful or suggestive information is likely to put it down with the slightest feeling of disappointment. The style is terse, but eminently readable; the opinions expressed by the author are often, no doubt, open to argument, but they have the great merit of conveying the impression that they are the opinions of a man who knows practically all that there is to be known about his subject, and who does not hesitate to state his own convictions, whether they are likely to be in agreement with those of other people or not. For example, we may refer to the little outburst of evident irritation at the need for the objectionable but compulsory guard-wires. These, the author holds, "do not strike at the root of the matter, which is to prohibit entirely uninsulated wires of any kind crossing above the trolley wires." Here speaks not the expert, but the tramway engineer; perhaps if fate had destined Mr. Rider to be a telegraph engineer, we

should have been told that the only thing to do was to prohibit entirely uninsulated wires of any kind from crossing below the telegraph wires. Why should the telegraph wire be banished underground rather than the overhead equipment changed to the conduit system which Mr. Rider has shown us can be so efficient? We fancy the objection which would be made to the change by either party would be the same—that they would prefer the other side to make it and to pay for it.

The ancient recipe for cooking a hare applies with particular force to the design of a system of electric tramways; the motto of the tramway engineer should always be "First catch your passenger." One cannot read this, or, indeed, any comprehensive book on electric traction, without being strongly impressed by the degree to which the whole of the engineering depends ultimately on the halfpenny passenger. The engineer builds a bridge, dams a river or constructs a railway from the Cape to Cairo, and the work is a piece of engineering almost pure and simple, but he may design and equip a first class traction system—generating station, engines, dynamos, cables, track, line and cars—and if he is out of his reckoning as to the time the housewife goes to market all his energy has been wasted. It is she who determines the kind of car and the kind of service, and, these once settled, everything else follows almost as a matter of course. It is here really that electric tramways and electric traction score so heavily; they have the flexibility which enables them to be designed to meet and to satisfy the requirements of the public in a way which cannot be done by the omnibus on the one hand or by the steam railway on the other. The fact that electric traction came into being when these other means of transport were in strong possession of the field has been to its own advantage; it has had to cater for the requirements of the public in a way to attract them from its rivals, and the success with which it has done so is shown by the reaction on the railways, which are one by one resorting to electrification as their only salvation.

Electric tramway and railway development in England has been for a long time retarded from various causes, but of late years it has been making steady progress. Though much has already been done, there is still a vast amount to do. Our large cities all afford transit problems which it is safe to say no other method of traction yet known can solve so satisfactorily, and when these, as socially the more pressing, have been tackled, the question of light railway construction between town and town still offers great fields for development. We have not here the opportunities which the Americans possess but we have problems of our own at once more difficult and more urgent of solution. London in particular is a case in point, and there can be no doubt that once the Royal Commission now sitting has reported electric traction schemes for London will be plentiful. The electrical engineer who decides to go in for traction work is certain before long of great opportunities; he cannot better prepare himself for taking advantage of those opportunities than by reading Mr. Rider's book.

MAURICE SOLOMON.

OUR BOOKSHELF.

Milk, its Production and Uses. With Chapters on Dairy Farming, the Diseases of Cattle, and on the Hygiene and Control of Supplies. By Edward F. Willoughby, M.D. (Lond.), D.P.H. (Lond. and Camb.). Pp. xii+259. (London: Charles Griffin and Co., Ltd., 1903.) Price 6s. net.

ALL medical men and hygienists must necessarily know something about milk and its production, and this work, in a comparatively small compass, deals very fully and adequately with the whole subject. The author, being scientific adviser to one of the largest of the London dairy companies, has had practical experience in all branches of the subject, and his views, therefore, are worthy of confidence. The first four chapters are devoted to a consideration of the various breeds of cows, the qualities of the milk they produce, and their housing, feeding, breeding, and diseases.

In the fifth chapter the legal aspects of diseases of cattle are discussed, and a useful summary of the "Diseases of Animals Acts" and of the "Dairies, Cowsheds and Milk Shops Orders" is given.

The important subjects of the elimination of tubercle and the inspection and control of cowsheds are briefly treated. The physiology and dietetics of milk, pasteurisation and sterilisation, condensed, skimmed, and separated milks, therapeutics of milk, koumiss and other milk preparations, and diseases conveyed by milk, all receive brief attention.

The book concludes with chapters on the dairy, on milk analysis, on control of adulteration, with an abstract of the Foods and Drugs Act, and on the bacteriological examination of milk. The whole work is eminently practical and readable. As regards the conveyance of scarlatina by milk, the well known Hendon outbreak is detailed, but no reference is made to Prof. Crookshank's researches, which throw considerable doubt on some of the conclusions arrived at by the officials of the Local Government Board. The author considers that the alleged tendency to scurvy or scurvy rickets in infants brought up on sterilised milk is not proven, and with this we agree. It is stated (p. 142) that Nuttall and Thierfelder failed to rear young rabbits and fowls brought into the world under aseptic conditions so that their intestinal tracts were free from bacteria. This is not the case; Nuttall and Thierfelder found that guinea-pigs (not rabbits) so reared were even more vigorous than animals reared under ordinary conditions.

The book will prove a useful work of reference, especially for medical officers of health, and the numerous excellent illustrations add considerably to its value.

R. T. HEWLETT.

A Treatise on the Principles and Practice of Dock Engineering. By Brysson Cunningham, Assoc.M.Inst.C.E. Pp. xviii + 559. (London: Charles Griffin and Co., Ltd., 1904.) Price 30s. net.

THE author of this book is on the engineering staff of the Mersey Docks and Harbour Board, which has control over the largest and most efficient system of docks in the world. During the last few years, under the direction of Mr. Lyster, the engineer-in-chief, these docks have been modernised and brought up to date. New deep-water basins and repairing docks have been built; the entrances and sills of some of the old docks have been lowered. Transit sheds and cranes of modern type have been erected, so that these docks are now able to deal with the largest class of vessels yet built, and to load and unload the largest

cargo steamers in the most rapid and efficient manner possible.

Mr. Cunningham has therefore had unrivalled opportunities of acquiring both a theoretical and practical knowledge of dock construction, and in the volume now under notice he has brought together in a concise and well organised form the results of the knowledge thus acquired. The author has not, however, relied solely on his own experience, but has freely made use of the information contained in the numerous papers on dock matters contributed to the *Proceedings* of the Institution of Civil Engineers and to the numerous reports of the International Navigation Congresses and other technical societies. Of these he has evidently been a diligent reader, as few points of interest in the *Proceedings* of the societies or in the technical journals that have been dealt with during the last few years seem to have escaped his notice.

While the study of this book may be regarded as essential to the younger engineers engaged in dock work, it will be invaluable as a book of reference to the expert engaged in this branch of engineering and its cognate interests.

The book is divided into twelve chapters, dealing in an exhaustive manner with the designing and construction of docks, the materials and plant required, the theory of construction of the walls and gates, the equipment and working of docks when constructed, the appliances required for the handling and transport of cargoes to and from the docks, and for repairing the vessels. The book is well illustrated, there being no less than 34 folding plates and 468 illustrations in the text. The book does great credit both to the author and to the publisher, but, of course, the greatest merit belongs to the former for having furnished the dock engineer with such a valuable aid to his work.

Electric Lighting and Power Distribution. Vol. ii. By W. P. Maycock, M.I.E.E. Pp. xxii+684. (London: Whittaker and Co., 1903.) Price 7*s.* 6*d.*

THIS little book covers a very great deal of ground, so that it is hardly necessary to say that no subject is discussed in any great detail. The opening chapters deal with dynamos, alternating currents and alternators, and these are followed by a chapter on electricity meters, in which most of the leading types are described and illustrated. The next chapter deals with motors; a dozen pages in this chapter are all that are devoted to electric tramways and railways, which will give some idea of the amount of consideration which each branch receives. Other chapters deal with batteries, transformers, and generating stations. The treatment throughout is of a very elementary character, but the descriptions are clear and concise, and the illustrations well selected and very clearly reproduced, so that the book should be of service to the student for the City Guilds and similar technological examinations, for whom it is primarily intended.

Builders' Quantities. By Herbert C. Grubb. Pp. viii+227. (London: Methuen and Co., 1904.) Price 4*s.* 6*d.*

THIS book has been prepared more particularly for the use of candidates studying for the examination in builders' quantities held by the City and Guilds of London Institute. The modes of measurement and examples of "taking off" are given in order for the work of all the trades employed in the erection and completion of a building; and these sections are followed by explanations of squaring dimensions, abstracting, and billing. The text is illustrated by seventy-seven figures.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Origin of the Horse.

THE receipt of a copy of Prof. J. C. Ewart's admirable paper on "The Multiple Origin of Horses and Ponies" suggests a few remarks. The paper in question is from the *Transactions* of the Highland and Agricultural Society of Scotland, 1904—one could wish that it had appeared in a publication which comes more regularly under the notice of zoologists. In a previous paper (*Proc.* Roy. Soc. Edinburgh, 1903) Prof. Ewart had shown conclusively that *Equus prjevalskii* was not a hybrid between the kiang and the common horse, and had arrived at the conclusion that it might very well rank as a valid species. Lydekker in 1902 had proposed to regard *E. prjevalskii* (or *przewalskii*) as a subspecies of *E. caballus*, and now Prof. Ewart does the same, while recognising also two other subspecies, *E. c. typicus* and *E. c. celticus*. The animal named *typicus* is the Norse horse, which is arbitrarily selected as the type of the Linnean *caballus*. The Celtic pony, still surviving in the pure state in Iceland, is given the new name *E. c. celticus*. In its way, Prof. Ewart's demonstration of the distinctive characters of this animal deserves to rank with Darwin's treatise on the primrose, as an example of genius applied to common things. The case is so clear that the author himself is evidently half inclined to regard the Celtic pony as a valid species, and it seems to me that the facts justify us in recognising three species of living horses, *E. prjevalskii* (Poliakoff), *E. celticus* (Ewart) and *E. caballus* (L.). The indications are that these animals were quite distinct in the wild state, and the fact that various blends between *caballus* and *celticus* exist in domestication is no more proof of specific identity than the same sort of thing is among the dogs, which nobody doubts to have originated from more than one wild species.

The use Prof. Ewart makes of the prehistoric cave drawings of horses is most suggestive. Possibly these sketches may have been taken a little too seriously in some instances, too little allowance being made for eccentricities in drawing. Fig. 27, from the Kesserloch cave, has a remarkably long body, and one might joyfully recognise the *Equus scotti*, Gidley, were it not that that animal inhabited the plains of Texas and New Mexico.[1] Prof. Ewart accepts the opinion that the living American horses are wholly of Transatlantic origin. While this is probably correct, I was surprised on looking into the matter a few years ago to find that the evidence was not so complete as I had supposed. It is said that the natives showed great surprise at the horses of the Spaniards, being evidently unacquainted with the animals. This was to be expected, for if wild horses lived in America at the time of Columbus, they surely were not in the "tierra caliente," but rather to the

[1] The New Mexico record is based on a molar tooth found by Miss Ada Springer in the Pleistocene beds of the Arroyo Pecos, Las Vegas, and examined by the writer It differed in no respect from Gidley's description and figure. Mr. Gidley kindly made for me a number of skull-measurements from the types of *E. scotti*, and I found upon comparisons that the five specimens were much more uniform than a similar series of *E. caballus* picked at random would be. This may be attributed no doubt to the greater uniformity of the wild species, but also to these particular specimens being apparently (from the circumstances of their discovery) members of the same herd. The skulls were 571 to 590 mm. long, and differed from any *caballus* of which I had measurements in (1) the rather longer muzzle, with the upper dental series (molars and premolars) considerably longer, 195 to 204 mm., and (2) apparently in the greater breadth between the orbits above, but Mr. Gidley afterwards wrote that he found that while the breadth between the *anterior* borders of the orbits of *scotti* is slightly greater than in large skulls of *caballus*, the breadth between the *posterior* borders is less; hence it would seem that the eyes of *scotti* looked less forward than those of *caballus*. The other measurements:—zygomatic breadth, greatest breadth of muzzle, least breadth of palate, distance between molars of opposite sides, and the greatest breadth of posterior nares, all fall within the limits of variation of *E. caballus*. Hence it is apparent that *E. scotti* was in many respects similar to *caballus*, as Mr. Gidley indicated in his paper on the subject. The bones other than the skull, taken separately, could not be distinguished from those of *caballus*. Other differences in the skulls than those mentioned have been fully described and illustrated by Mr. Gidley, and the facts need not be repeated. No doubt a more minute study of the osteological characters of fossil horses would throw valuable light on the significance of variations in the living forms.

north, in the region of the prairies. Moreover, even if the natives had known the horse, they might well have been astonished at the horse-and-man combination.[1] Then it is difficult to understand why Equus became totally extinct, since subsequent events showed that vast areas were admirably adapted to it. Prof. Ewart informed me (*litt.* 1902) that the Chinese were alleged to have visited America about the eleventh century, and reported it as the "land of women, the horse and the vine." This tradition is apparently not to be regarded very seriously, but the antiquity of the genuine *Equus caballus* in North America is supported by O. P. Hay in his excellent catalogue of the fossil Vertebrata of North America (1902), p. 622. This author boldly lists *E. caballus* as Pleistocene on this continent, and while admitting that "in some cases the identifications have been open to question," and "in other cases the remains may have been derived from the introduced race," he adds, "the former existence of the species in Alaska and in California appears well established." Of course, the term *E. caballus* must here be understood in the wider sense. Prof. Ewart also remarked, in the letter just cited, that the Spaniards at the time of the conquest used small-headed horses, "the offspring of the *E. fossilis* of Asia in all probability," whereas the characteristic "buckskin" pony of our south-west is a relatively large-headed animal. Furthermore, Mr. Wilfred Blunt, through my brother, Mr. S. C. Cockerell, communicated the statement that "the Spaniards never rode mares, and can hardly have brought any but stallions with them in their ships to their colonies." Hence the early abundance of wild horses in North and South America appears very remarkable. With reference to the presumed early absence of horses, one may also remark that so common an animal as the "antelope" (Antilocapra) was not made known to naturalists until about 1815, and a perfectly new wild sheep was discovered in northern Mexico in 1901! Even the known variability in colour of the wild horses might be thought of as a Mendelian phenomenon, resulting from the mixture of different types, and the infusion of new blood could be conceived to have resulted in greater vigour and consequent increase in numbers.

T. D. A. Cockerell.

Colorado Springs, Colorado, U.S.A.

This paper, only slightly abridged and with about one-third of the figures, appeared in Nature of April 21 (vol. lxix. p. 590). I am more than "half inclined to regard the Celtic pony as a valid species" and to recognise three species of living horses. I prefer, however, to leave systematists to decide whether Prjevalsky's horse and the Celtic pony should be regarded as species or merely as varieties.

J. C. E.

Entropy.

An author expects some unfavourable reviews, and, if wise, profits largely by them; but Prof. Perry's review of "Entropy" in Nature of April 14 is simply an attempt to brush away a book the object of which is to eradicate what, I submit, is a very widespread mistake, because the reviewer has himself not only made the mistake, if mistake it be, but championed it. This mistake is that entropy is conservative in irreversible change; that the entropy of a body is increased only by its taking in heat, or that $\int dH/\theta$ is the entropy in irreversible change; or that dH/θ is a complete differential. In Prof. Perry's own words, "There is a property of the stuff called its entropy ϕ, which is such that any change in it, $\delta\phi$ if multiplied by t the absolute temperature gives δH or $\delta H = t\delta\phi$." "ϕ is to heat re-received H something like what v is to work w." "If we divide every δH by t, . . . every amount δH being divided by the t at the time, and if we call δH divided by the t by the name, entropy, we shall find that when the stuff is brought back to its old state again, we have just given out as much entropy as we have taken in. The account balances exactly."

In a note to a presidential address I pointed out that such statements are numerically correct in reversible changes only, that in all irreversible changes they are not accurate, and that they thus give a wholly wrong idea of the function entropy. There was no question, and never has been, about reversible changes, that is to say, changes where p and θ are uniform throughout the working substance; the whole of my criticism refers to irreversible changes alone.

Prof. Perry then started a correspondence in which Prof. Poincaré and Prof. Planck were good enough to join, and also showed how Prof. Perry was wrong (*Electrician*, March 13, 1903). I quote from Prof. Planck's letter:—

"The controversy excites my attention the more, when, to my astonishment, I see a man so well known and so eminent in science as Sir Oliver Lodge[1] putting forward ideas on thermodynamics (*Electrician*, January 23, p. 460) which I combated ever since the commencement of my studies in that science."

"But how can I hope with my words to make any impression on such writers when Mr. Swinburne's excellent articles have failed to effect any change in their preconceived ideas? For, with one reservation,[2] what he has written in the *Electrical Review* (January 9, p. 52) is, in my opinion, one of the best and clearest expositions of the subject that has ever been written, especially where he points out that Nature never undertakes any change unless her interests are served by an increase of entropy, while man endeavours so to make use of those changes allowed by Nature that his own interests—namely, the acquisition of available energy—are served as completely as possible."

Science can never be a matter of authority, but I quote Prof. Planck because Prof. Perry now reviews the book as if his definition of entropy was universally accepted in thermodynamics, and adopts the tone that anyone who differs from himself and develops Clausius's inequality, $\int dH/\theta < \phi$ for all irreversible changes, is wrong *prima facie*.

Though the review contains quotations from the little book, they are always incomplete, so as to give as far as possible an absurd meaning. Thus the quotations about errors in text-books look as if I said text-books on thermodynamics are wrong. What I do say is that books on physics and steam engines define ϕ as $\int dH/\theta$, whereas books on thermodynamics show that is accurate for reversible changes only. The whole gist of my book is the application of Clausius's principle of increase of entropy. Books on steam engines, and generally on physics, as opposed to those on thermodynamics, say $d\phi = dH/\theta$, and dH/θ is a complete differential. If θ means the temperature of the working substance when that temperature is not uniform, dH/θ has no meaning, and is not a complete differential. By θ in irreversible change, as I have often explained, I mean the temperature at the separating surface through which dH passes. If no meaning can be given to dH/θ in irreversible change, my criticism that dH/θ is not a complete differential, except in the ideal case of reversibility, is still valid. "It is hardly believable that in a dynamical illustration he should imagine the momentum of a system of two colliding bodies to be increased by the collision" is calculated to give the impression that I am ignorant of elementary mechanics. The context is discussing the sum of the scalar momenta of gas particles. This increases when some isolated gas equalises its temperature at constant volume. "But as we have the foot-pound,

[1] Some of the aboriginal pictographs show horses, but these are apparently of recent date. Unfortunately we have no ancient American drawings of animals comparable to those of Europe.

[1] The reference to Sir Oliver Lodge occurs because he wrote an article on entropy defined so that $H = \int \theta d\phi$, which I take it he has recalled. It was because I thought the weight of his authority might tell harmfully that I sent the correspondence to two leading authorities on thermodynamics.

[2] This was my statement that $d\phi$ is never a complete differential in irreversible change. For $d\phi$ to be a complete differential in terms of, say, $d\theta$, dv, we must have $d\phi = Md\theta + Ndv$, where $\partial M/\partial v = \partial N/\partial\theta$. To prove $d\phi$ a perfect differential during any irreversible change the equation must be true while the change is going on. It is not accurate to put the value of θ or of p which obtained before the change started, or would be reached if the change were arrested and the substance allowed to come to uniform temperature and pressure. Prof. Planck is so much better a physicist and mathematician than I am that I do not contradict such an authority; I merely say there is a misunderstanding, which may be mine, and I submit my contention. My view is that the physical meaning of a complete differential in mechanics is not only that the integral is completely determined by the coordinates, but that it is conservative. Lagrange's treatment of mechanics really involved the conservation of energy, that is to say of the forms he discussed.

and I think the poundal, as units of energy" looks as if I confuse force and energy. The context shows that I object to non-metric units as unscientific, and therefore do not care which unit bears the name poundal. The statement that I want to have Claus instead of Rank for the British unit of entropy is wrong. The claus is the unit of entropy in the practical metric system where the joule is the unit of energy. The rank is a name proposed by Prof. Perry for $\int dH/\theta$, and as this is not entropy in any real change, I cannot adopt it as a unit of entropy. As to $d\chi$, I will deal with that elsewhere; it is a side issue. The statement that I talk of "the entropy of a quantity of heat" is wrong. Prof. Perry holds that entropy is a factor of heat. I dissent, and agree with Prof. Planck that entropy is not a factor of energy. So far from talking of the entropy of a quantity of heat, I have explained very fully how and why entropy is in no sense a factor of heat.

I would not write were a review in NATURE not particularly important, and I trust you will, in fairness to my publishers and myself, allow this letter to appear.

41 Palace Court, W., May 1. JAMES SWINBURNE.

MY sole object in the controversy to which Mr. Swinburne refers was to show that, like most of the other writers of whom he complained, I have never either made or championed the mistakes he speaks of at the beginning of this letter. As to my notice of his book, I cannot admit that I have misrepresented him except as to the *claus*. I made a mistake in saying that his claus is what is sometimes called a *rank*. As he now says that the momentum of which he spoke was a *scalar* momentum, I submit that I was quite fair in my comments. I cannot admit that his $\theta\chi$ diagram is a side issue. JOHN PERRY.

Origin of Plants Common to Europe and America.

THAT there is a resemblance between the floras of Canada and northern Europe, and again between the floras of Canada and of eastern Siberia and Japan, is well known. Including the horsetails and ferns with the flowering plants, probably about 575 species are identical in Canada and Europe, and again about 330 in Canada and Japan or the River Amur country. A large number of these are common to the three continents. The hypothesis generally accepted has been that, in some comparatively recent epochs, there has been a connection between Europe and America which facilitated the intermingling of the plant life of the two continents. The late Prof. Asa Gray suggested the probability that the migration of European plants had taken place across Asia to America. Lesquereux, from his studies of the flora of the Dakota group, on the other hand, maintained that the North American flora is not now, nor has it been in past geological ages, the result of migration, but that it is indigenous. It has long been known that species now extinct occurring in the Miocene of Europe had appeared in America at an earlier period. Lester Ward enumerates eleven species—all now extinct—as common to the Laramie group in the United States and the Eocene of Europe, and shows further that at least two living species now found in both Japan and America date their origin in America as far back as the Eocene. Twenty years ago my own studies in the distribution of Canadian plants also convinced me that whilst facilities had existed for migration in both an easterly and a westerly direction, Canada was the point of origin of many of the species now identical in Europe and America. This conviction has been heightened by further knowledge of the range in Canada of these identical species and by further discoveries during recent years of plants in the Pleistocene clays of Canada. Of seventy fossil species in these Pleistocene clays at Toronto, Ottawa and elsewhere, twenty occur at the present day in both Europe and Canada, fourteen are similarly Asiatic and Canadian, whilst eleven are common to the three continents. This, if it does not necessarily indicate that in Pleistocene times the intermingling of these floras had already been effected, at least shows that in this period these identical species were present in Canada, and had here their place of origin if there is nothing to indicate their presence at as early a period in Europe or Asia. In its vast areas of exposed Laurentian and Huronian formations, Canada has an old look about it, and must have furnished a home through long past ages for the growth and diffusion of northern temperate plant life, when other sections of the globe have from time to time been under water.

The peculiarities of the present range over Canada of many of these identical species also afford suggestions. Whilst many of them are distributed somewhat generally over the country, and many are high northern or Arctic, quite a number do not range west of Lake Superior; others have not been found west of the Rocky Mountains, whilst some are confined to British Columbia and Alaska. In view of their occurrence also in either Asia or Europe, this circumscribed range of so many species suggests their antiquity, and that the elevation of that lofty barrier, the Rocky Mountains, and the disturbance of the relations of land and water in Manitoba and the North-West Territories in more recent times, has resulted in these plants being confined to their present range where forest conditions were more suitable, and has led to the treeless prairies and plains being tenanted by new groups of species specially suited to the new conditions there, when the land rose to its existing level. A. T. DRUMMOND.

Toronto, April.

Moisture in the Atmosphere of Mars.

IN your issue of May 5 I see a note in the astronomical column on Mr. Lowell's theory of the Martian canals. It is perhaps not just to criticise it on so short a summary, but there is a point on which I should like to ask a question. If, as Mr. Lowell says, there is not sufficient moisture on the planet to produce vegetation, how does the water return to the poles ready for the next summer? The only way, it seems to me, is by evaporation. His suggestion of artificial waterways to carry the water from the polar caps implies the existence of an atmosphere sufficiently dense to enable intelligent beings to live. That being so, is it not just as plausible that the evaporated water should condense in the form of rain on the general body of the planet as well as at the poles? although, of course, the excessive cold would account for an increased fall at these extremities.

Bournemouth, May 10. ARTHUR J. HAWKES.

Radium and Milk.

IN the souring of milk the amount of lactic acid developed may reach 0·80 per cent. in three or four days when the milk solidifies. In view of Sir O. Lodge's suggestion (NATURE, October 1, 1903), I have made experiments comparing the rate of acidification, in two to three days, with and without the influence of radium rays from a 5 mgrm. radium bromide tube. The differences in five cases did not exceed the limit of experimental error, 0·01 per cent. of lactic acid, and in a sixth case with the milk solidified the difference only amounted to 0·05 per cent. of lactic acid. It therefore appears to me that under normal conditions radium rays have little or no effect on the functions of the lactic acid bacillus. WILLIAM ACKROYD.

Halifax.

THE BANTU RACES OF SOUTH AFRICA.[1]

NOTHING so good as this book dealing with the Negro indigenes of southern Africa has yet appeared. Mr. Dudley Kidd's work is therefore entitled to take the first rank on this subject, at any rate as far as the Bantu races of South Africa are concerned.

It is a national humiliation to us to reflect that as a Government we have been connected with South Africa for more than a century, that is to say, two-thirds as long as our imperial connection with India has lasted, and yet that by Government endeavour or

[1] "The Essential Kafir." By Dudley Kidd. Pp. xiii+436. (London A. and C. Black, 1904.) Price 18s. net.

private research so little of value has been published in the English language on the native human races of Africa south of the Zambezi. The present reviewer does not overlook the excellent but incomplete work of the late Dr. Bleek, of Sir George Grey and of McCall Theall, nor should the short work by Theophilus Hahn on the Supreme Being of the Hottentots be left unmentioned. The author of the work under review is also right in calling attention to the value of the Rev. Canon Callaway's work, published in the 'sixties of the last century on the religious system of the Zulus; and the writings of the French Protestant missionary Casalis on the Basuto and Bechuana languages should not be left unrecorded.

The author gives at the end of his book, "The Essential Kafir," a bibliography of the works written in English and French on the Hottentot, Bushmen and Bantu races of Southern Africa. He has omitted to include a variety of books in the German language on the Damara (Ova-herero) people and language. But these (which are by no means final, comprehensive, or even particularly valuable) have owed nothing in their inception to the British rule over South Africa. Consequently the slur still remains, especially when we compare such a list as is given in the Appendix to "The Essential Kafir," with a list which might be compiled of works on the native races and languages of India, or even of British Central Africa. It is difficult to understand why scientific Anthropology has played so poor a part in British South Africa; but no doubt it is due to the fact that the great personages, appointed or self-made, who have ruled over or have influenced South Africa during the last hundred years, never, with the exception of Sir George Grey, took the slightest interest in these questions, or cared to enlighten themselves or others on the characteristics of the native races whose doings or misdoings were provocative of so much bloodshed and expenditure of money.

Even those who have left on record their studies of the Negro races in South Africa—with the exception of Dr. Bleek seem to have carried on those studies with little or no reference to the lands beyond the Zambezi. Many South Africans fancy that the linguistic term Bantu, which was first coined by Dr. Bleek, applies wholly to the Zulu-Kafir-Bechuana peoples of the South African Colonies, and do not realise that it was intended by Dr. Bleek, and has since been used, to cover nearly all that section of the Negro race which inhabits the southern half of Africa between the northern limits of the Congo basin and the Equatorial Lake regions and the eastern districts of Cape Colony.[1]

FIG. 1.—A Swazie making Fire by Friction. From "The Essential Kafir," by Dudley Kidd

Consciously or unconsciously, Mr. Kidd in the book under review brings out emphatically the "Central African" characteristics of the Zulu-Kafir people. (It would be a good thing for consistency of speech if we induced the world at large to drop the term "Kafir," and to apply some such name as Zulu to all those Bantu tribes in South Africa—as apart from the Bechuana, the Herero, and the Zambezi people—which speak dialects of the Zulu language. Kafir—originally spelt Caffre—was the Portuguese rendering of the Arabic "Kafir," plural "Kufar," which means "infidel" or a race not believing in Islam. When the Portuguese vessels first rounded the Cape

[1] Dr. Bleek's use of "Bantu" was more connected with linguistic classifications. Whether there is a negro physical type which is connected with the making of this distinct group of languages is still undetermined; Dr. F. Shrubsall, the anthropologist, thinks there is.

of Good Hope and touched at the coast of south-east Africa, they found Arabs or Arab half-castes trading there, and learning that these called the black natives of the country "Kafirs," they adopted this term henceforth as the designation of the Bantu coast races of southern Africa, and passed on this word to the Dutch, who handed it over to the English. Mr. Kidd, by his excellent and detailed description of Kafir customs, myths, folklore, songs, dances, and implements, shows how inseparable these people are in classification from the Negro races of tropical Africa. This deduction is in varying degrees affected by an examination of South African Bantu languages. Of this subject Mr. Kidd does not treat at any length, but it might be mentioned that a careful study of such linguistic works as those of the late Dr. Bleek brings out the following points:—

A study of the existing languages of the Ova-herero of south-west Africa, of the many Bechuana tribes of central South Africa, and the languages of the Zulu-Kafirs from Cape Colony on the west and south to the Portuguese district of Inhambane (Nyambane) shows that there is fundamentally a common though remote parentage to these languages so far as the vocabulary and grammatical structure are concerned; that is to say, that there is more evidence of inter-relationship between these three groups than there is between any one of them and the Bantu languages to the north and north-east. But there are still very striking differences in phonology between the Herero, Bechuana, and Zulu groups, showing that the history and wanderings of each section must have differed considerably. The Bechuana languages are the most altered from the original Bantu structure, but they are without the clicks which seem to give a Hottentot aspect to the Zulu dialects, and I believe that very little that is Hottentot can be traced in the etymology of the Bechuana vocabulary. But the phonology of this language is so peculiar as to suggest its great isolation at one period from other Bantu dialects. Some students of Bantu languages, however, have thought that the Bechuana races may have been the pioneers of the Bantu invasion into the regions across the Zambezi.

Physically speaking, the various sections of the Bechuana people exhibit far more traces of intermixture with the Hottentot-Bushmen type than is shown by the Zulu-Kafirs or by the real Herero (Damara) people.[1] The languages of the Herero group, though they possess marked characteristics in phonology, are of a very pure Bantu type, and gradually link up northwards with the languages of the Congo coast and with the Bantu speech of the southern portions of the Congo basin. The Zulu language retains some primitive characteristics in the form of the prefixes, which have been changed or lost in the Bechuana or Herero groups. Yet in other respects the Zulu dialects have departed widely from the Bantu standard, especially in vocabulary. This language group is a curious mixture of archaic Bantu features and inexplicable elements which, if not "Non-Bantu," cannot be definitely traced to any known Bantu group of tongues. In a few cases words of this description are of Hottentot origin, but this does not explain many of them, which would appear to have been absolutely invented by the Zulu people, no doubt owing to that strange custom (by no means unknown elsewhere in Africa), of "hlonipa," by which a constant local change of vocabulary takes place owing to the dislike to mentioning names of things which resemble the names of relatives; so that if there be a prominent person in the tribe, for instance, whose name is actually equivalent to "ox," or even whose name sounds like the word for ox, in that village or community the ox will henceforth be known by a paraphrase or by a substituted word.

[1] Except of course the Hill Damaras, who are a mysterious tribe of mountain people in the northern parts of German South-west Africa—a black race similar in appearance to some of the more degraded Negro tribes of West Africa, but speaking a corrupt dialect of Hottentot.

In many respects—as Mr. Kidd's work shows over and over again—the Zulu-Kafir race would seem to have been the last arrived of the Bantu peoples in southern Africa, and to have reached that part of the continent at no very remote period—possibly not more than 1,500 to 2,000 years ago. In some of their characteristics the Zulus irresistibly recall the manners and customs of such Nilotic-Negro races as the Masai, though there is absolutely no linguistic connection between the two peoples. No doubt this can be explained by assuming that the original Bantu group from which the Zulu sprang had sent several previous branches to invade South Africa, which may have been the originators of some of the Zambezi tribes, of the Bechuana and the Herero, and that in this original home, somewhere up in east-central Africa, the Zulu peoples came into contact with Nilotic-Negro races from whom they borrowed customs, arms, and methods of warfare, and with whom they shared religious beliefs. When the Zulus started forth on their southward migration their progress seems to have been a relatively rapid one. We need not be astonished at this when we reflect on the remarkable speed with which a small section of the Zulu people in the first decades of the nineteenth century rushed back into Central Africa, reaching in their raids and settlements even the vicinity of the Victoria Nyanza.

The author has much to say of interest on the vexed question of the clicks in Zulu. There are three clicks in this Bantu language—the only Bantu form of speech which possesses these sounds. Some have considered that they were borrowed from the Hottentot, but of late there has been a tendency on the part of students like Mr. Dudley Kidd and Miss A. Werner to argue that these modern clicks in Zulu have been separately developed without Hottentot parentage. Mr. Kidd points out that at the present day the clicks subsist far more in the language of the women than in that of the men. It should be noted that amongst the settlements of Zulus in east-central Africa, which are about seventy years old, the clicks are rapidly disappearing. Dr. Bleek pointed out in his linguistic studies that certain strong intercalated aspirates met with in Swahili, and in one or two other East African Bantu dialects were not dissimilar to a vanishing click.

The space at my disposal does not permit of my dealing further with the interesting problems raised by this book, which, however, I must repeat, is perhaps quite the best that has yet been written or compiled about the Bantu negroes of South Africa. The hundred plates that illustrate this book are all photographs of perfect execution and singular aptness.

H. H. Johnston.

PROF. E. J. MAREY.

Of the two veteran Frenchmen who entered on their careers as physiological discoverers half a century ago, Marey and Chauveau, the first has left us. The second is in full vigour and is at this moment engaged in active laboratory work.

Marey died on Sunday night after an illness of much suffering. His earliest investigations had for their purpose the devising of methods by which the arterial pulsations could be made to inscribe themselves on an equably moving surface so as to obtain a graphic record from which their time-relations could be determined. One of the earliest products of these

methods was the invention of the sphygmograph, of which the original form (1863) has not undergone any important modification. From the arteries he proceeded to the heart, and for this associated himself with Chauveau, with whom his early friendship persisted unbroken to the end. It was to this association of two able men, one of whom was at that time the most skilful of living experimenters, while the other possessed an equally exceptional faculty of mechanical invention, that we may attribute the splendid researches on which our present knowledge of the motion of the heart is founded.

The results of these investigations were communicated to the Academy of Sciences in the early 'sixties, and soon after published in Marey's first book ("Physiologie Médicale de la Circulation du Sang") in 1863. This work was followed by others, of which were the "Travaux du Laboratoire," published annually by M. Marey after he had succeeded Bernard as professor in the Collège de France. In these he completed the development of the "graphic method" in its relation to the circulation, and extended its application to other bodily movements, particularly to those of locomotion, including the flight of birds. It thus happens that the "kinematographic" method, which in later times has not only been vulgarised for public entertainment, but has served a higher purpose as a guide in the artistic representation of animal motion, was in the first instance devised by Marey for the purpose of physiological research.

It would be difficult to over-estimate the value of Marey's work to the science to which, for the last half-century, he has devoted himself. Full of original ideas and fruitful in resources for carrying them into effect, his ingenious methods have not only served his own purposes, but have been made available by other workers in all investigations relating to the mechanical functions of the animal body. It would be difficult to find a single instance of a research in the carrying out of which these methods have not been employed.

PROF. WILHELM HIS.

PROF. WILHELM HIS, whose death was announced from Leipzig on May 1, at the age of seventy-three, altered and extended our knowledge of human anatomy more than any man of his time. He discovered and wrote the history of the human body during the first and second months of conception, and thus filled in what, until his time, was almost a blank. He introduced more accurate methods of studying the form and relationships of the various organs of the body. Pupils went to him from all parts of the earth and carried back to their native universities the quiet, honest spirit of investigation, the complete methods and the accurate technique His had introduced in his laboratory at Leipzig. His influence to-day is world-wide; it is especially evident in the remarkable progress in embryological research made recently in the United States.

As His entered to lecture one was struck by the absence of those bodily features one expects in a German professor. He was a Swiss by birth and education, having been born at Basel in 1831; in appearance he might have been an Englishman. His narrow, longish head, black hair, regular profile, long sallow face, and nervous temperament indicated his descent from a Celtic stock. He taught quietly, clearly, and concisely, illustrating his subject as he spoke by marvellous drawing on the blackboard. He relegated lady-students to the back-bench. Long after the university doors were shut, a light could be seen in the window of his private room, for to him work was also amusement.

His career as a medical student is interesting. It began at the University of Basel when he was eighteen, and finished there in 1854 when he was in his twenty-third year, but during that period he visited and worked at the Universities of Bern, Berlin, Würzburg, Vienna, and Prague, selecting what was best at each place. After graduating he studied in Paris. In 1857, then twenty-six, he succeeded Meissner as professor of anatomy and physiology in Basel, and commenced his life's work.

It is always a matter of the utmost interest to know the circumstances that determine the direction of a successful line of research. His, in his student days, while working at Würzburg with Virchow, then a young enthusiast, commenced and afterwards finished an investigation into the structure of the cornea of the eye, and in the early years of his professorship published, with Billroth, a research into the structure of lymphatic glands and allied bodies. A lecture which he heard Remak give in Berlin on the developments of glands was really the starting point of his embryological work. The point which struck him as marvellous was the development of a gland such as the liver from two of the three primary layers of the embryo. He commenced to investigate the origin and the part which each of these three primary layers played (ectoderm, mesoderm, and hypoderm) in the development of each part of the body, first in fowls and lower vertebrates, and subsequently in the then almost unknown early human embryo.

Every advance in science rests on the introduction of a new method. By the methods he employed His succeeded where other men had failed. The early human embryo is minute and jelly like; it has to be hardened and stained before it can be cut in microscopic sections; it has to be stained to differentiate its various constituent layers; it has to be cut with a mathematical regularity in order that each section may be magnified and modelled in wax so that, by placing these wax magnifications together, a reconstruction of the embryo may be obtained. Although His did not invent any one of these details, yet he improved each of them and applied them to the study of embryos with an accuracy that never has and never will be surpassed. Duplicates of the models thus constructed are to be seen in all anatomical museums, and are of the greatest service to those who teach as well as to those who pursue embryological research.

The work of Prof. His is not marked by brilliant generalisations or discoveries, nor can his outlook on the kingdom of living things be said to be a wide one. He represented most realistically what he saw, but his power of interpreting embryological facts was limited by his neglect of comparative anatomy. Perhaps the greatest of his discoveries was the manner in which nerve fibres are developed. He was the first to see that they were processes produced by nerve cells. If his limitations are mentioned, it must also be admitted that most of what we know of the early development of all the systems of the human body we owe to him.

Ludwig, who made Leipzig the Mecca of physiologists, early recognised the ability of the young Swiss anatomist, and was instrumental, in 1872, in having him appointed director and professor of anatomy in the University of Leipzig. During the thirty-two years he laboured there, the younger anatomists flocked to him, and by placing his time, advice, and encouragement freely at their disposal, he rendered them deeply his debtors.

NOTES.

In connection with the assembly of the International Association of Academies next week, the international council of the International Catalogue of Scientific Literature will also meet. The following are the members of this council, and the countries they represent:—Prof. H. E. Armstrong, F.R.S., Great Britain; Prof. H. Poincaré and Dr. J. Deniker, France; Dr. W. T. Blanford, F.R.S., India; Dr. M. Knudsen, Denmark; Prof. R. Nasini, Italy; Captain H. J. Lyons, R.E., Egypt; Prof. A. Famintzin, Russia; Prof. Dr. Karl von Than, Hungary; Dr. J. Brunchorst, Norway; Monsieur D. G. Métaxas, Greece; Prof. Dr. D. J. Korteweg, Holland; and Prof. A. Liversidge, New South Wales.

The Weights and Measures (Metric System) Bill was read a third time in the House of Lords on Tuesday, and was passed with various amendments proposed by the public departments to the Select Committee to which the Bill was referred.

Sir William Ramsay has just been elected an honorary member of the "Bunsen Gesellschaft."

Prof. G. H. Darwin, F.R.S., has been elected a foreign associate of the U.S. National Academy of Sciences.

We regret to see the announcement of the death of Prof. G. J. Allman, F.R.S., for more than forty years professor of mathematics in Queen's College, Galway.

The council of the Geological Society of London has this year awarded the Daniel Pidgeon fund to Mr. Linsdall Richardson, of Cheltenham.

The *Times* correspondent at St. John's, Newfoundland, states that Lieut. Peary is chartering the sealer *Eagle* for a cruise to Littleton Island, from July to September, in preparation for a four years' stay in the Arctic regions, beginning next season.

A mathematical society of Vienna has been organised, the meetings of which are to be held monthly. The officers are Messrs. G. von Escherich (president), E. Müller and W. Wirtinger (vice-presidents), A. Lampa (secretary), and A. Gerstel (treasurer).

A fund has been started by the Faculty of Sciences and the Engineering School of Rome with the object of raising some kind of memorial to the late Prof. Cremona. The secretary is Signor I. Sonzogno, 5 Piazza San-Pietro in Vincoli, Rome.

The Royal Academy of Sciences of Madrid offers for 1905 a prize for the best essay written in Spanish or Latin on the following subject:—"A complete study of a special class of singular integrals arising from differential equations for which the values of the derived functions become indeterminate when certain relations exist between the simultaneous values of the principal variables."

Further particulars have been recently issued regarding the mathematical congress which, as announced last summer in Nature, is to take place at Heidelberg from August 8 to 13. There will be six sections, and in addition five conferences presided over by Profs. Wirtinger, Greenhill, Darboux, Segre and Königsberger. It is proposed to hold exhibitions of mathematical models and of mathematical books.

A series of prizes is offered by the mathematical and natural science section of the "Jablonow" Society of Leipzig for themes connected with the following subjects:—For 1904, the chemical differentiation of rock magmas; for 1905, the causes of plasmic currents in vegetable cells; for 1906, the analogues of Bernouilli's numbers in the study of elliptic functions; and for 1907, the laws of photoelectric currents. Full particulars are obtainable from the secretary, Prof. Wilhelm Scheibner, 8 Schletterstrasse, Leipzig.

A brief notice of the late Edmund Hess, who died at Heidelberg on December 24, 1903, is given in a note in *L'Enseignement mathematique*, vi., 2. Hess was born at Marburg on February 17, 1843, and studied mathematics there from 1860 to 1862. The next year he went to Heidelberg, where he studied under Hesse, from whom he acquired his taste for geometry. He subsequently occupied the post of assistant at the Observatory of Göttingen, and in 1866 returned to Marburg, where he held office at first as extraordinary and later as ordinary professor. His papers deal exclusively with geometry, the subjects including "theory of the division of the sphere" and "contributions to the theory of configurations in space."

The ninth annual congress of the South-Eastern Union of Scientific Societies will be held at Maidstone on June 9–11. Mr. F. W. Rudler, the president-elect, will deliver an address on the evening of June 9, and papers will be read on the mornings of June 10 and June 11. There will be several excursions to places of interest to naturalists and archæologists. The hon. general secretary is Mr. G. Abbot, 33 Upper Grosvenor Road, Tunbridge Wells.

On Tuesday next, May 24, Mr. H. F. Newall will begin a course of two lectures at the Royal Institution on the solar corona; on Thursday, May 26, Mr. H. G. Wells will deliver the first of two lectures on literature and the State; and on Saturday, May 28, Sir Martin Conway will begin a course of two lectures on Spitsbergen in the seventeenth century. The Friday evening discourse on May 27 will be delivered by the Prince of Monaco on the progress of oceanography, and on June 3 by Prof. Svante Arrhenius on the development of the theory of electrolytic dissociation.

A correspondent directs our attention to a singular mistake of dates in Mr. Herbert Spencer's "Autobiography." Referring to his visit to Montreal in 1882, Mr. Spencer states (vol. ii. p. 392):—"The meeting of the British Association had ended before our arrival." The meeting of the British Association in Montreal was in 1884, so this was probably a meeting of the American Association for the Advancement of Science which Spencer refers to. This conjecture appears to be confirmed on p. 384, where in a letter to Prof. Youmans he refers to the possibility of attending the meeting of the association at Montreal and supporting Prof. Youmans in his position of chairman of the Committee of Science Teaching.

During the anniversary meeting of the Royal Geographical Society on Monday, the Royal medals for the encouragement of geographical science and discovery were presented; the Founder's medal to Sir Harry H. Johnston, for his explorations and investigations in Africa, and the Patron's medal to Commander Robert F. Scott, R.N., for his conduct of the National Antarctic Expedition, and especially for his sledge journey to 82° 17′ S. The following other awards were also made:—the Murchison grant for 1904 to Lieut. Colbeck, for his services to the society while in command of the relief expeditions; the Cuthbert Peek grant for 1904 to Don Juan Villalta, for important geographical dis-

coveries to the east of the Andes, while in command of a Peruvian exploring expedition; the Gill memorial for 1904 to Captain Irizar, Argentine Navy, for his very successful expedition for the rescue of the Nordenskjöld Antarctic Expedition; the Back grant for 1904 to Dr. M. A. Stein, for his valuable geographical work in Central Asia, and especially for his mapping in the Sarikol and Kwen-Lun ranges.

The Russian papers report that a rather severe shock of earthquake occurred at Shemakha (Caucasus) on April 28 at 6.30 p.m.

A new expedition, under M. Tolmachoff, is being organised by the Russian Geographical Society for the exploration of the region between the mouths of the Yenisei and the Lena.

Records obtained by observers in several parts of the world suggest that an appreciable general diminution of the transparency of the earth's atmosphere took place some time during the year 1902, but disappeared at some time during 1903. As this is an important matter and may possibly be made the basis of an explanation of other meteorological phenomena, Prof. Cleveland Abbe, U.S. Department of Agriculture (Weather Bureau), Washington, D.C., asks observers to send him any records that will assist in defining the dates of beginning and ending, and the extent of this change in transparency. Such records may consist of photometric or photographic observations of the brightness of the stars, changes in the solar or stellar spectra, unusual prevalence of halos, large Bishop's ring, or haze; observations of heat received from the sun, as made with actinometers or pyrheliometers; observations of the polarisation of the blue sky light and of scintillation of the stars. It is proposed to incorporate the results of the inquiry in a general article on the subject of atmospheric transparency.

We have received notice from Dr. H. Hergesell, president of the International Committee for Scientific Balloon Ascents, that a new edition of the useful cloud atlas, prepared at the request of the International Meteorological Committee by MM. L. Teisserenc de Bort, H. Hildebrandsson and A. Riggenbach, and issued in Paris, under the special superintendence of the first named gentleman in 1896, will be undertaken if sufficient interest is taken in the matter by scientific men. We believe the atlas in question to be the best of the kind, and that the beautiful representations of various types of clouds have been of great use in connection with the scientific balloon and kite observations to which we have frequently directed attention. Dr. Hergesell (Strassburg) states that he will be glad to receive and to send to M. Teisserenc de Bort any suggestions from persons who have used the atlas, with the view of improving the proposed new edition.

The report and results of observations for the year 1903, issued by Mr. J. Baxendell, meteorologist to the Southport Corporation, shows that the high-class work carried on at the Fernley Observatory has been fully maintained. The various experiments on anemometers have been continued, and several improvements in connection with self-registering apparatus have been effected. A new instrument for continuously recording the variations in the inclination of the wind was designed and constructed by Mr. Halliwell, chief assistant at the observatory, and is now at work at the anemograph station. A useful article on the meteorology of Southport was prepared during the year for the "British Association Handbook" of local information for the Southport meeting. The usual interesting comparison of statistics of various health resorts is appended to the report.

At Leeds on May 12 Prof. Clifford Allbutt, F.R.S., opened a new public dispensary, the building of which has cost 33,000*l.* In the course of an address Prof. Allbutt remarked that medical men are engaged in destroying their own means of livelihood by preventing disease, and have attained very remarkable success. Diseases which were once rampant are now diminishing. Typhus has never been seen by some members of the medical profession. Typhoid fever has been reduced to a nominal amount, and there has been a reduction of pulmonary consumption all over England. Discoveries as to the nature of malaria have changed the face of important countries. Prof. Allbutt urged that preventing disease is more congenial than curing it, and suggested that a rise of the standard of general health would be achieved by the careful study of the origin and causes of disease in such an institution as that of the Leeds General Infirmary.

A copy of the *Peterborough Advertiser* of May 7 has been sent to us, containing the announcement that radium has been found in beds of Oxford Clay near Fletton, Huntingdonshire. No particulars are given, but a long descriptive article on the discovery suggests that it will make "brickfields better than gold mines." These sanguine anticipations will perhaps be tempered by the following extract from a paper by Prof. J. J. Thomson, read before the Cambridge Philosophical Society on February 15:—"Radium was found in garden soil from the laboratory garden, in the Cambridge gault, in gravel from a pit at Chesterton, in still greater quantities in sand from the sea-shore at Whitby, in the blue lias at Whitby, in powdered glass, in one specimen of flour, and in a specimen of precipitated silica."

A note in Nature of May 5 (p. 12) refers to some results obtained by Prof. A. Stefanini and Dr. L. Magri concerning the action of radium on the electric spark. Mr. R. S. Willows writes from the Cass Institute, Jewry Street, E.C., to say that he has been making observations on this subject for some time, and has come to practically the same conclusions as those arrived at by the Italian physicists. He remarks:—"My experiments are not sufficiently advanced to justify me in stating completely my results, but since the action can be greatly hindered by a magnetic field, I have come to the conclusion that it arises from the β rays given off by the radium."

In continuation of notes in previous numbers recording the progress of geographical research in Madagascar, the April issue of *La Géographie* contains an account of the geodetic and cartographical work carried out during 1902 and 1903. A sketch map showing the different triangulations and a table of determined positions accompany the article.

The May number of the *Geographical Journal* contains short articles of varied interest ranging over many parts of the subject. The president summarises the second season's work of the *Discovery* in the Antarctic regions. Captain Philip Maud writes on the exploration of the southern borderland of Abyssinia; Lieutenant Irizar on the rescue of the Swedish Antarctic Expedition; Colonel G. E. Church on the Acre territory and the caoutchouc region of south-western Amazonia; and Mr. Claud Russell on a journey from Peking to Tsitsihar. Dr. Vaughan Cornish contributes an elaborate discussion of observations on the dimensions of deep-sea waves, and there are papers on a bathymetrical survey of the lakes of New Zealand by Mr. Keith Lucas, and on peat moors of the Pennines by Mr. C. E. Moss.

The Geological Society of Belgium has issued a special memoir on the flow of underground waters in limestone regions. This is edited by M. E. Van den Broeck (Brussels, April). Having regard to the importance of determining the source of water used for drinking purposes, the underground course pursued by it, until it issues again in the form of springs, must if possible be ascertained. Observations on this subject are now brought forward and discussed. The use of colouring matters is generally regarded as the best means of determining the question, and especially with regard to the time occupied by the water in its transit through the strata. Fluorescein, which gives a green tint, has been held by a number of hydrologists to afford the most satisfactory results, while others have expressed the opinion that it serves to retard the flow of water, and that different matters in solution or in suspension have travelled more rapidly. It is, however, maintained that neither floating objects nor matters in suspension can give so true a notion of the flow as substances in solution, but the substance in solution must not augment the density. It is admitted that light, carbonic acid and peaty soil tend to decolorise the fluorescein. The influence of light is most important, and must be obviated. The decolorisation produced by carbonic acid can be counteracted by ammonia. It is generally concluded that fluorescein will prove the existence of communication between two points, and will give the best approximate idea of the time taken in transit. The fluorescope is necessary to detect its presence.

A photographic portrait of Francis Galton, admirable both in execution and as a likeness, is given in *Biometrika* (vol. ii. part iv.). The accompanying sketch of the same subject is also good and characteristic. The most important memoir in the part is Prof. Karl Pearson and Dr. Alice Lee's paper on the inheritance of physical characters. This embodies the fruit of many years' arduous labour, and establishes several results of high importance. Among these are the existence of statistical evidence of sexual selection, and the near approach to uniformity of the regression value of both physical and psychical characters as shown in fraternal inheritance. The former point receives indirect confirmation from a paper on assortative mating. Variation in *Ophiocoma nigra* is dealt with by Mr. D. C. McIntosh, and Mr. W. P. Ellerton contributes tables of powers and sums of powers of natural numbers up to 100. In the miscellanea, Prof. Pearson takes occasion to offer a vigorous defence of the position that "biometry is essentially a science of exact quantitative definition, and if it is to be of service in rendering anthropology an exact branch of science, it must replace vague ideas by numerically definite conceptions."

The results of the important experiments on the crossing of Japanese waltzing and albino mice, reports of which have already appeared, are collected and fully discussed by Mr. Darbishire in *Biometrika*, vol. iii. part i. While certain of the crossings gave results in accordance with Mendel's law, Darbishire shows reason for the view that ancestral influence cannot be excluded, and that Mendel's theory of the purity of gametes receives no support from the present series of experiments. Referring to the variability of "heterozygotes" and their divergence in character from the parental standard, the author observes:—"It seems to me that we have not got any further in this direction than Darwin had when he called phenomena of this kind reversions to ancestral condition." Incidentally, he shows that the results of his crossings afford no instance of telegony. Among the other memoirs in this part is the record of a striking and valuable experiment by Mr. A. P. di Cesnola on the protection from enemies secured by the coloration of *Mantis religiosa*. So far as the experiment went, the proof of protection enjoyed by the mantis in appropriate surroundings appeared to be complete, while it was also made clear that both green and brown forms are eaten by birds or ants when recognised. New ground is broken by Mr. Greenwood in a paper on the variability and correlation of the human viscera, and Prof. Weldon shows that Mendelian segregation does not, as has been suggested, obtain among human albinos in Sicily.

In the *Independent Review* for May, Dr. A. R. Wallace completes his survey of the chain of evidence connecting the "Islands of Wák-Wák" of the "Arabian Nights" with the Aru Islands, the home of the great bird-of-paradise. Hasan's journey through the "land of wild horses" is shown to refer to Tibet, whence the traveller crossed China to the sea, and eventually reached the Malay Peninsula. The apparently supernatural marvels encountered on the voyage from Malacca to the Aru Islands are all ingeniously demonstrated by Mr. Wallace to rest on a substratum of actual fact. Not that Hasan himself ever reached those islands, of which he was told by those who had accomplished the journey. Two separate legends appear to have been combined in the story of Hasan as we now know it. "The one is founded upon the magnificent plumage of the bird. . . . On the other hand, the cry 'wák-wák,' as distinctly stated by the General, gave the name to a mountain, and also to the islands themselves, and was said to be made, not by any bird, but by human heads which grew upon trees, and at daybreak gave forth this cry. . . . There is not a word in the whole story to show that there was thought to be any connection between the mysterious voices and the magical plumes."

We have received from the publishers (Messrs. Cassell and Co., Ltd.) a copy of a new popular edition of that useful little work, "The Field Naturalist's Handbook," originally compiled by the late Rev. J. G. Wood, and revised by the Rev. T. Wood. As the new edition is published at the price of one shilling, it is within the reach of all, and everyone interested in field natural history should buy a copy. Perhaps it may be well to remind our readers that the work is restricted to three groups specially favoured by collectors, namely, butterflies and moths, wild plants, and birds' eggs, and the proper seasons to look for the various kinds of each group are fully recorded in the tables. The scientific nomenclature, so far at least as Lepidoptera and birds are concerned, is of an old-fashioned type, but perhaps in the main it is none the worse for this, although some restriction of the scope of generic names would certainly have been advisable in the case of the ducks. In works of this nature it would perhaps be nowadays advisable to speak of "a scientific name" rather than "the scientific name" of a species. This little volume, which is an excellent example of careful editing, deserves a wide circulation.

A third edition, which has been revised and enlarged, of Mr. W. Perren Maycock's "First Book of Electricity and Magnetism" has been published by Messrs. Whittaker and Co.

"The Psychological Index, No. 10," a bibliography of the literature of psychology and cognate subjects for 1903, has been published in connection with the *Psychological Review*. The index has been compiled by Prof. Howard C. Warren, of Princeton University, with the cooperation of M. G. Revault D'Allonnes, of Paris; Mr. F. G. Bruner,

of Columbia University; and Mr. C. S. Myers, of the University of Cambridge.

Messrs. Pastorelli and Rapkin, Ltd., have submitted to us for inspection specimens of their patent "dial" barograph and of their student's standard barometer. In the case of the barograph we notice that the action of both dial hand and recording arm is simultaneous, the same movement controlling the two. Should the pen not indicate upon the chart a reading coinciding with that shown by the dial hand, this can be rectified by means of a milled head at the side of the dial case. Another milled head moves pen and dial hand simultaneously, and thus makes it possible to set the instrument to agree with a standard barometer, or to adjust for altitude correction. The student's standard barometer is constructed on the Fortin principle, and provides an accurate instrument at a moderate cost.

The new issue—that for 1904—of the "Statesman's Year-Book" (Macmillan, 10s. 6d. net), edited by Dr. Scott Keltie with the assistance of Mr. I. P. A. Renwick, contains several novel and valuable features. The introductory section of the volume includes statistical tables and diagrams exhibiting with admirable clearness the conditions of British trade and shipping from 1860 down to last year. A diagram is also included showing the distribution among the various fleets of the Belleville and other boilers. Panama, as an independent State, is accorded a separate section, as are also the See and Church of Rome, which in former issues have appeared together as a section under Italy. The statistics in other parts of the volume (which runs to 1398 pages) have been brought up to date by the aid of official returns. The annual publication of this compendium of the most trustworthy information available as to the various States of the world is a convenience to everyone interested in political geography and a necessity to all who have to make use of books of reference.

The additions to the Zoological Society's Gardens during the past week include a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, presented by the Hon. Mrs. Algernon Bourke; four Smith's Dwarf Lemurs (*Microcebus smithi*) from Madagascar, a Bosman's Potto (*Perodicticus potto*) from West Africa, presented by Mr. Percy H. Stormont; a Mona Monkey (*Cercopithecus mona*) from West Africa, presented by Mr. W. Hughes; a Common Raccoon (*Procyon lotor*) from North America, presented by Mr. P. Estcourt Holland; three Blood-breasted Pigeons (*Phlogaenas luzonica*) from the Philippine Islands, presented by Dr. L. Wynne Davies; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. J. Smyth; two Lobed Chameleons (*Chamaeleon parvilobus*) from South Africa, presented by Mrs. Cox; a Tarantula Spider (*Avicularia avicularia*) from the Lower Amazons, presented by Mr. J. W. A. Watkins; an Antilopine Kangaroo (*Macropus antilopinus*) from North Australia, a Yellow-handed Howler (*Mycetes beelzebul*) from the Lower Amazons, a Senegal Galago (*Galago senegalensis*) from Senegal, a Common Wolf (*Canis lupus*), two European Sousliks (*Spermophilus citellus*), European; a Dingo (*Canis dingo*) from Australia, two Grooved Tortoises (*Testudo calcarata*) from South Africa, deposited; two Spoonbills (*Platalea leucorodia*), two Cayman Island Amazons (*Chrysotis caymanensis*) from the Grand Cayman, purchased; a Corean Bull (*Bos taurus*, var.), three Crab-eating Raccoons (*Procyon lotor*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

June Meteors.—June does not usually prove itself a very prolific month in furnishing meteors, and a sufficient reason is found in the strong twilight prevailing in high northern latitudes at this period. But there are a few very interesting showers to be observed. Very brilliant meteors are often directed from near Antares (α Scorpii), the radiant being at 252°–21°. Nearly every year one or several fireballs from this southern stream appear over England, but the observations are often not sufficiently exact and numerous for their real paths to be determined.

There is an active radiant in June from 313°+60° near α Cephei. These meteors are swift, and they may quite possibly be connected with comet 1850 I., which has a radiant on June 23–24 in same position.

There is another shower in Cepheus from 335°+57° near ζ, which is particularly well defined at midsummer, and seems to be actively continued during July, August and September.

June is also a good month for Cygnids. There are fairly active showers from β, θ, δ and α Cygni. In June, 1887, a number of meteors were seen diverging from radiants at 252°+11° (near α Herculis), 274°+69° (ω Draconis), and 280°+43° (α Lyræ). It is probable that all these showers recur annually, though with variable strength.

A Spectroheliograph for the Catania Observatory.—Prof. Orlando, the Italian Minister of Public Instruction, has granted L3000 (125*l.*) to the Observatory of Catania for the purchase of a spectroheliograph. The acquisition of such an instrument will enable Profs. Ricco and Tacchini to participate more fully in the proposed international daily study of the solar phenomena, and thereby add to the important solar work which has already been performed at the Observatory of Catania.

The Parallax of λ Andromedæ.—In a letter to the May issue of the *Observatory*, Mr. J. E. Gore directs the attention of those astronomers who are engaged in parallax determinations to the spectroscopic binary λ Andromedæ. From a consideration of the published elements it appears that the mass of the bright component of this system is only about one-tenth that of the sun. In order that a body with this mass and with a surface luminosity equal to that of the sun might appear as bright as λ Andromedæ (mag. = 4·0), it would have to be comparatively near to the earth. Mr. Gore's theoretical value of the parallax is 0″·34, and this is probably too low, for a comparison of their respective spectra leads to the conclusion that the surface luminosity of the sun is the greater. The star has a considerable proper motion, equal to 0·0157 in R.A. and 0″·425 in declination, according to the Greenwich ten year catalogue.

The Repsold Registering Micrometer.—In No. 3943 of the *Astronomische Nachrichten*, Prof. K. Oertel discusses the results obtained with the Repsold self-registering micrometer which is attached to the meridian circle of the Munchen Observatory.

An analysis of these results leads Prof. Oertel to claim many advantages for this instrument as compared with the older form of micrometer. Among other advantages he mentions the following:—The personal equation is either entirely absent or extremely small. Differences of magnitude in the observed stars do not influence the results. The accuracy of the results is greater than in the older method. The observations take less time, one observer being able to observe between thirty and forty stars, in both co-ordinates, during one hour.

The Spectroscopic Binary β Aurigæ.—In an article published in No. 3944 of the *Astronomische Nachrichten*, Prof. Vogel contests the validity of Herr Tikhoff's conclusions (*Astronomische Nachrichten*, No. 3916) concerning the system of the spectroscopic binary β Aurigæ, which stated that the system was probably made up of two separate pairs, and that the period was 3d. 23h. 30·4m. From the reduction of thirty-nine spectrograms obtained between December 22, 1903, and February 9, 1904, Prof. Vogel concludes that the period is 3d. 23h. 2m. 16s. ± 5s., and that the orbit is nearly circular in form. He also states that the reason for believing the system to be made up of *four* bodies is, to him, obscure.

THE EDUCATION OF EXAMINERS.[1]

THE subject that I have chosen for my presidential address may at first sight seem far from inviting. Yet, in spite of the unusual title of my paper, I undertake to say that most of you present here to-day will follow the results which I shall lay before you with ease, and will find a growing interest in certain ideas which cannot but prove novel to those of you who have not before thought of examiners as belonging to the human race, and therefore capable of education.

In a sense we are all examiners. We note and tabulate events and their causes. We distribute mankind into ethnological groups, or compare them as industrial workers. We ascertain their wants and their means of satisfying those wants. We examine and record the growth of custom, the physical and mental development of the human being, the changes in the mind itself and the order of such changes, the progress and decay of language, the distribution of wealth, the progress of society. Even the laws of statistics are submitted to examination.

Thus, side by side with the advance of theory in connection with all the sciences that fall under this section (archæology, education, mental science, philology, political economy, sociology, statistics), goes the scrutiny of results. It is justifiable, therefore, to think that an examination of methods of examination, even in connection with only one of those subjects, will throw a light upon such methods in general. I propose to-day to consider that small part of education which consists in the testing of the results of study by written papers.

You will perhaps wonder how it is that I have taken such an interest in the doings of examiners. The fact is that I am one of the few persons who have been for a lengthy period in the position of an examiner of examiners. In the position which I held in the Civil Service Commission for nearly fifteen years, it was my daily task to consider the character of the papers set by some of the highest dignitaries at Oxford and Cambridge, and other universities, to candidates for appointments in the English Civil Service. I had, moreover, to investigate the marking of the written answers of candidates, and to say whether the general results appeared to me to be fair and trustworthy.

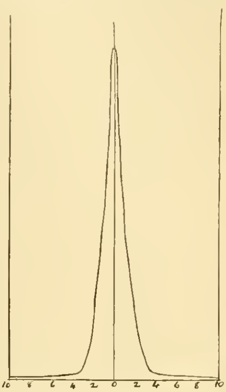
Of course, it will be understood that there are good as well as bad examiners. If the methods of good examiners are compared together, it will be found that they tend to uniformity, and that their results have certain characteristics in common. Whereas the methods and results of bad examiners differ from one another in every conceivable way.

But how are these results to be shown? It is not possible to obtain such information by running the eye down the totals awarded to candidates in the mark-sheets. Patient study will no doubt do something, but, where figures occur irregularly, it is hard to appreciate their import without definite classification.

In these days of the almost universal use of "squared" paper, all that is required is to find the percentages of candidates obtaining marks between the limits named, and to mark them off by counting the squares, say five candidates to a square. If the maximum in the subject is not 100, then it is only necessary to reduce the marks to that scale. By joining the top points of the vertical lines, which we call ordinates, the characteristic curve of the examiner is obtained, or, what is even more satisfactory, if black columns are raised on the bases 0 to 10, 11 to 20, &c., to show the number of candidates within these limits of marks, the result is a number of stepping-stones, shown in silhouette, and rising and falling in general harmony with the curve.

Difficulties presented themselves to me as soon as I began to plot the results of examiners from their mark-sheets. Until this had been done it was impossible to analyse the character of the marking, even after hours of study of the mark-sheets themselves. But as soon as the graphical representation had been arrived at, the whole matter was simplified. It was only necessary to determine whether there was any special form of curve to which the many varieties that have been placed before you ought to tend, or whether each subject, and even each examiner, might be properly represented by a different curve. I very soon became convinced that there was a tendency among the best examiners in many subjects to obtain results which gave the graphical form of a gendarme's hat (Fig. 2).

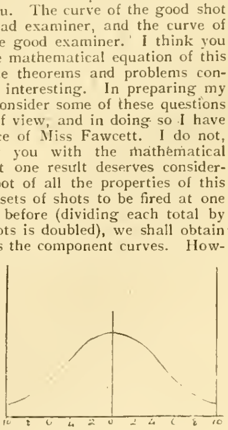
This form is one which is recognised by mathematicians as belonging to the so-called curve of "errors." I can best illustrate what is meant by this curve by supposing that some person in this room, experienced in the use of fire-arms, were asked to fire shots at a paper target on which a vertical straight line had been drawn as the mark to be aimed at. After a large number of shots had been fired, you would find that the holes in the target were arranged in about equal numbers on either side of the line, and that very few had actually hit the mark. If the distance of each shot from the centre line were measured and entered on a table, we should find so many falling within one inch of the line, so many between one inch and two inches, and so on. The curve now placed before you (Fig. 1) is produced by showing the number of shots falling within one inch on one side as a column of proportionate height erected on a base reaching one inch from the centre line. Similarly the column showing the number between one and two inches is drawn on a base between one and two inches from the centre line, and so on.



Deviation in inches.

FIG. 1.—Curve showing Pistol Practice at Vertical Line (good shot).

Now I show you a second curve (Fig. 2), in which the pistol has been put into the hands of an inexperienced person. You will at once perceive that these two curves are familiar to you. The curve of the good shot resembles the curve of the bad examiner, and the curve of the bad shot the curve of the good examiner. I think you will spare me giving you the mathematical equation of this curve, although many of the theorems and problems connected with it are extremely interesting. In preparing my paper to-day I have had to consider some of these questions from a mathematical point of view, and in doing so I have had the inestimable assistance of Miss Fawcett. I do not, however, propose to weary you with the mathematical treatment of the subject, but one result deserves consideration, because it is at the root of all the properties of this curve. If we allow the two sets of shots to be fired at one target, and classify them as before (dividing each total by two, since the number of shots is doubled), we shall obtain a curve of the same family as the component curves. However many times the process is repeated, each marksman will repeat his identical curve—on the supposition that he does not improve owing to practice—and of course the resultant curve due to both sets will be repeated.



Deviation in inches.

FIG. 2.—Curve showing Pistol Practice at Vertical Line (inexperienced shot).

Instead of taking only two performers with the pistol of unequal merit, we may bring within our view a considerable number in an ascending or descending scale of accuracy, and trace upon one sheet a series of these curves. Here is such a series (Fig. 3).

In each of these curves it should be noticed that the extreme portions never touch the base line, but they approach closer and closer to that line, so that the area enclosed in each case between it and the curve in question

[1] Abridged from an address delivered before Section D of the South African Association for the Advancement of Science on April 5 by Mr. E. B. Sargant, Education Adviser to Lord Milner.

depends upon a portion on each side of the middle ordinate which is at a measurable distance from that ordinate. Where the practice is accurate, the portion of the whole figure that may be safely excluded in calculating the area is much larger than in the cases where the shooting is wild.

A measure of the accuracy of the marksmen is obtained by drawing an ordinate to divide into equal parts the half area to the right or left of the middle ordinate, and estimating the distance between these two ordinates.

The whole area under consideration represents the total number of shots, and is therefore the same in the case of each curve. For the sake of simplicity we may suppose that 100 shots are fired. It is not true that that number of shots will in any case give the exact curve. We should only obtain its precise form by firing an infinite number of shots and then reducing the whole to a percentage. But for the sake of simplicity in our argument we will talk of 100 shots as the number that has been fired, and say that the area is proportional to that number. We see, then, that all the areas enclosed by each of these curves respectively and the base line are equal; and this gives us a simple way of plotting any one series if a single curve has been drawn. It is only necessary to suppose the curve to be stretched to a certain extent in either the horizontal or vertical direction, and to be contracted to a proportionate extent in the other direction, in order to pass to another curve of the series. In fact, if one of the curves were painted on a stretched india-rubber sheet, all the other curves could be got from it by pulling the sheet in one direction and slacking it off in the other.

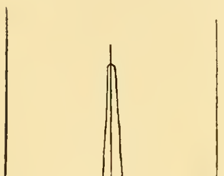


FIG. 3.—Series of Curves of "Error."

Another plan would be to bend a loop of wire into the form of one of the curves, and to place a lamp behind it so as to throw the shadow upon a screen. The loop and lamp might then be easily made to move in such a manner that the shadows in the successive positions gave the whole series of curves.

You will notice in the figure the points which show the intersection of neighbouring curves with one another. This is called, in mathematical language, the envelope of the family of curves. In this case it is a portion of two rectangular hyperbolæ.

Now, instead of our performers with the pistol, let us take the case of a series of examiners. As soon as I had observed that the curves of good examiners tended to approximate to the curve of errors, I cast about for the reason of this similarity. It is not far to seek. If we consider one particular candidate as the mean candidate, that is, a candidate such that there are as many above him as below him, we shall see how natural it is that the candidates should group themselves about this central figure as the pistol shots about the mean shot. It is clear that the curve of the good examiner should resemble the curve of the bad shot. The object of examination is to separate the candidates from one another as widely as is permissible under the given conditions, while the object of the target-practice is to get as many shots near the central line as possible.

Here we come to a most important limitation. You have already noticed that the curves we have been considering never touch the base line, that is to say, given a sufficient number of candidates, there will always be one or two removed to an extraordinary degree from the bulk of their fellows. But the examiner is obliged to give marks within certain limits, which he fixes arbitrarily as 0 and 100. If he were to place his zero point at a very great distance from the middle point, representing 50 marks, he would be able, no doubt, to make allowance for extraordinary candidates; on the other hand, the bulk of the candidates would be placed so close together that he would not be able to distinguish between them in any satisfactory manner. He is therefore bound to choose points such that the areas enclosed between the base line and the curve which lies beyond those points are very small compared with the areas up to the middle line. All the candidates beyond those points must be considered as having either nought or full marks.

Now you will see, I think, how an examiner in English composition, especially if he is a university man who has become acquainted with the finest examples of literature, tends to get a very steep form of curve (Fig. 4). He looks at some one paper, which differs to a considerable extent as regards both style and matter from the mean paper, and says, "This paper should have 80 marks at least." But then he thinks, perhaps unconsciously, "How do I know that, before finishing the pile of papers before me, I shall not find a budding Milton or Addison or Charles Lamb? If I give this candidate 80 marks, shall I be able to assign its true value to a composition of such extraordinary merit?" So he only awards 60 marks to the composition, and finds almost certainly, when he comes to the end of his pile, that no candidate has received any mark near 100. It is too late now to begin marking the papers all over again, and accordingly he sends in returns which do not serve to distinguish between the candidates in English composition to the same extent as they are distinguished in geometrical drawing, for example. The result is that a good candidate in the former subject is treated unfairly as compared with a good candidate in the latter subject.

FIG. 4.—English Composition.

Again, we see why a curve (Fig. 5) based on marking dictation papers by the system of deductions is so abnormal. In this case, the examiner, without considering minor defects, makes a certain deduction for each mistake in spelling. If 10 marks are taken off for each mistake, all candidates having more than ten errors receive no marks, whereas if we were to assign negative marks, the curve of errors would almost certainly be reproduced, the mean ordinate being below the zero point. The divergence which you perceive near the point representing full marks is due to there being a good many candidates who make no important mistakes. If minor defects, such as refinements of punctuation, were considered, and the scale stretched beyond 100, this divergence would also disappear.

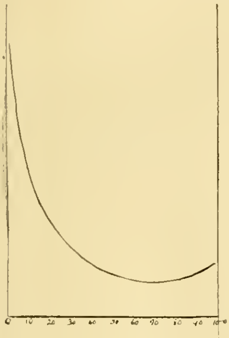
The problem which presented itself was how to bring these very different results into some accord. In order to give equal weight to various subjects having the same maximum, it seemed to me necessary that the examiners should have a common standard to work up to. Accordingly, during the latter period of my service with the Civil Service Commission, I caused such a diagram as has been placed before you to be printed on the sheet containing the examiner's report of his work. On that diagram, also, was printed a curve resembling a moderate sized gendarme's hat. If, as often happened, the examiner had 1000 papers to mark, he was requested to go through a batch of 100 taken at hazard, and to plot his curve upon the diagram. After a few examinations an old hand would probably find that his curve for the first 100 resembled closely the standard curve before him, but a fresh examiner might find himself altogether beside the mark. In such a case he was asked

to put aside the first 100 papers and to begin marking the fresh papers on such different lines as would, in his judgment, produce an approximation to the normal curve. On the supposition that he had achieved that result for the second 100, and continued to find that his curve was pretty constant for the third 100, fourth 100, and so on, he was asked at the end of all the papers to re-mark the first 100.

You might imagine that many examiners disliked having to place themselves upon this bed of Procrustes, but in the generality of cases it was not so. They positively took a delight in examining themselves. The process became one of self-education in marking.

Before leaving this part of my subject I should like to warn you that certain causes, which an examiner cannot always control, may make it difficult to obtain such an ideal curve as I have shown. It is not possible for me to enter fully into this part of the subject, but I will point out one cause at least that he can control—I mean the examination paper.

Good marking will not compensate for a bad paper. Every candidate must have his chance, in some question or other. Otherwise the examination is like a hurdle-race in which the hurdles are so high that a considerable number of candidates find themselves stopped from reaching the goal at all. The curve, in such a case, tends to assume a shape of this kind, mounting very rapidly to the zero line (Fig. 5)—just the curve, in fact, which we have already seen in connection with a dictation paper. In this case it is not the marking which is wrong, but the examination paper.



Number of marks gained.

FIG. 5.—Dictation Paper.

Accordingly, I found in practice that it was necessary to point out to examiners, before ever their papers were proposed in manuscript, that they ought to divide their questions roughly into (say) three portions, of which one portion could be answered by candidates of inferior power, a second should be within the range of mediocre candidates, and a third only possible to candidates who might be classed as good to excellent. The result of these directions was that examiners soon found little difficulty in spreading out their candidates in the desired way. In setting their questions they had before their eyes the little gendarme's hat.

Among the causes, beyond the control of the examiner, which may interfere with the formation of this curve, we must reckon as in the first rank:—(1) such a small number of candidates as does not give fair play to the law of probabilities; (2) any selection of candidates by a preliminary examination or other means.

With regard to the causes just named, I will only say that it has been found that the method can be applied successfully when there are not less than one hundred candidates, and that, even below this number, the curve, though irregular in formation, gives us very useful information as to an examiner's capacities. With regard to the second cause, a great deal can be done to produce a satisfactory curve by setting such questions in the further papers as are only addressed to the candidates who remain after the preliminary sifting.

I trust that I have now fulfilled the promise with which I started, namely, to show you how examiners themselves may be examined; and not only this, but you will understand that it is possible to educate examiners so as to enable them to form a much more accurate and sustained judgment of a large number of candidates than would have been within their power without such preliminary guidance.

THE CHEMICAL REGULATION OF THE SECRETORY PROCESS.[1]

THE researches which we wish to bring briefly before the Royal Society deal with the mechanism of adaptation to changes in the food and the chemical correlation of the activities of different organs engaged in the digestion and assimilation of the food.

According to Pawlow, the secretion of the pancreatic juice is exactly comparable to the secretion of saliva, and is effected by a nervous reflex. The starting point of this reflex is the stimulation of the duodenal mucous membrane by the chyme, or by substances such as oil, ether, or oil of mustard. Not only is the pancreatic juice turned out into the intestine just at the time when it is required, but, according to Pawlow, the composition of the juice varies according to the food, the proteolytic ferment being increased by a diet of meat, while the amylolytic ferment is increased by a starchy diet. This adaptation of the glandular activity was ascribed by him to a species of "taste" in the mucous membrane. It was imagined that the different constituents of the food excited different nerve endings, which, in their turn, caused reflex activity of different mechanisms in the pancreas itself. The field of these assumed reflexes was considerably narrowed by the researches of Popielski (*Gazette Clinique de Botkin*, 1900) and Wertheimer (*Journal de Physiologie*, vol. iii. p. 335, 1901), who showed that the introduction of acid into the duodenum was productive of secretion even after destruction of all nerve connections of the pancreas and alimentary canal with the central nervous system, and even after extirpation of the sympathetic ganglia of the solar plexus. It was with a view to determine the mechanisms of this reflex secretion of the pancreas, as well as of the adaptation of the pancreatic secretion to variations in the food of the animal, that we began our researches.

The last named authors had also shown that the secretion occurred, but in smaller quantities, if the acid was inserted in any part of the small intestine, with the exception of the lower end of the ileum. It was thus easy to examine the effects of the introduction of acid into a loop of ileum in which all nerve connections with the pancreas, or with the rest of the body, had been destroyed. This crucial experiment had, curiously, not been performed by previous workers in the subject. On carrying it out, we found that destruction of all nerve connections made no difference to the result of introducing the acid. The pancreatic secretion occurred as in a normal animal. It was therefore evident that we had to do here with a chemical rather than a nervous mechanism. Previous work had narrowed the question down to such a degree that the further steps were obvious. We knew already that the introduction of acid into the blood-stream had no influence on the pancreas; hence the acid introduced into the intestine must be changed in its passage to the blood-vessels through the epithelial cells, or must produce in these cells some substance which, on access to the blood stream, evoked in the pancreas a secretion. This was found to be the case. On rubbing up the mucous membrane with acid, and injecting the mixture into the blood-stream, a copious secretion of pancreatic juice was produced. It was then found that the active substance, which we call *secretin*, was produced by the action of acid from a precursor in the mucous membrane, probably in the epithelial cells themselves. Once formed by the action of acid, it could be boiled, neutralised, or made alkaline, without undergoing destruction. The precursor of the substance (*pro-secretin*) cannot be extracted by any means that we have tried from the mucous membrane. Even after coagulation of the mucous membrane by heat or alcohol, however, secretin can still be extracted from the coagulated mass by the action of warm dilute acid.

We have not yet succeeded in determining the chemical nature of secretin, though we have obtained chemical evidence which will serve to exclude certain classes of substances. Thus the fact that it will stand boiling shows that it is neither a coagulable proteid nor a ferment. It is soluble in 90 per cent. alcohol in the presence of ether, but it is insoluble in absolute alcohol and ether. It is slightly diffusible through animal membranes. It can be

[1] Abstract of the Croonian Lecture. By Dr. W. M. Bayliss, F.R.S., and Prof. E. H. Starling, F.R.S. Read before the Royal Society, March 24.

filtered through a gelatinised Chamberland filter. It is not precipitated by tannic acid, thus excluding bodies of alkaloid nature as well as diamido-compounds. This evidence, slight though it is, points to secretin being a body of relatively small molecular weight and not a colloid. It may be compared to the active principle of the suprarenal glands, adrenalin, which has been obtained in a crystalline form and the chemical constitution of which has been approximately determined. This is, indeed, what one would expect of a substance which has to be turned out into the blood at repeated intervals in order to produce in some distant organ or organs a physiological response proportional to the dose. The bodies of higher molecular weight, such as the toxins, which owe their activity, according to Ehrlich, to the fact that they can be directly assimilated by the cells of the body, and built up into the protoplasmic molecule, always give rise to the production of anti-bodies, a process which, while not preventing necessarily their utilisation in the body, would prevent their acting as a physiological stimulus to certain definite cells. Adrenalin and secretin on the other hand belong to the class of drugs which act by their physicochemical properties, and the physiological effect of which is determined by the total configuration of their molecule. It was suggested to us early in our experiments that the secretion of pancreatic juice, evoked by secretin, was essentially a sudden production of an anti-body; such a sudden production is unknown in the animal body, and the anti-character of the secretion is at once negatived by the fact that secretin can be mixed with a freshly secreted juice without in any way destroying its efficiency.

Like adrenalin, secretin is extremely easily oxidised, and it is probable that it is got rid of in this way from the body, since, even after repeated injections of secretin, it is impossible to find this substance or any precursor of it either in the pancreas, the urine, or other tissues of the body. Just as in the case of adrenalin, so we find that secretin is not specific for the individual or species. An extract of the mucous membrane of the dog will evoke secretion in the pancreas of the frog, the bird, rabbit, cat, or monkey. In the same way the pancreatic secretion of the dog can be excited by injection of secretin prepared from the intestine of man, cat, monkey, rabbit, fowl, salmon, skate, frog, or tortoise. The evolution of this mechanism is, therefore, to be sought at some time anterior to the development of vertebrates.

The action of secretin is not confined to the pancreas. It has long been known that the pancreatic juice, in order to exert its full activity on the food stuffs, needs the simultaneous presence of bile, and the fact that in many cases the two fluids are poured into the duodenum by a common orifice shows the close connection which must exist between them. Digestion of fats is impossible unless both fluids have access to the gut, and even in the digestion of carbohydrates, as was shown by S. Martin and Dawson Williams many years ago, the presence of bile greatly hastens the digestive powers of the pancreatic juice. Whenever, therefore, a secretion of pancreatic juice is required, a simultaneous secretion of bile is also necessary. It is interesting to note that this simultaneous secretion is provided for by the same mechanism by which the secretion of pancreatic juice is evoked. If the flow of bile be determined by measuring the outflow from a cannula placed in the bile duct, it will be found that introduction of acid into the duodenum causes a quickened secretion of this fluid. The same increase in the secretion of bile can be produced by injecting solutions of secretin into the blood stream. This influence of secretin on the liver has been fully confirmed by Falloise. This observer has shown that acid extracts of the intestinal mucous membrane cause an increase in the bile secretion most marked when the extract is made from the duodenum and diminishing as the extract is taken from the lower parts of the gut, that from the lower section of the ileum being quite ineffective.

The discovery of secretin has placed in the hands of physiologists the power of controlling the activity of a gland by purely physiological means, and we have taken opportunity of the control thus acquired to investigate the exact character of the changes induced in the pancreas under this physiological stimulus. So far as we can tell secretin has no specific influence on any one constituent of the pancreatic juice. When injected it causes secretion of a juice which is normal in that it resembles the juice secreted on entry of food into duodenum, and contains a precursor of trypsin, amylopsin, and steapsin. Secretin, in fact, appears to cause the pancreatic cells to turn out the whole of the mesostates which they have accumulated during rest in preparation for the act of secretion. If secretin be injected at repeated intervals until the gland will no longer respond to the injection, it is found on microscopic examination that the cells have discharged the whole of their granules. In sections stained with toluidine blue and eosin the whole of the cells stain blue in marked contrast to the normal resting gland, where one-half or two-thirds of the inner margin of the cells is taken up with brilliantly stained red granules. This effect is not produced in all cases. In some animals we have injected secretin at frequent intervals over a period of eight hours, and obtained at the end of the experiment a secretion as vigorous as after the first injection. The pancreas in this case was evidently not fatigued, and on killing the animal and examining this organ microscopically it was found to give the typical picture of a resting pancreas. One may say, therefore, that under healthy conditions the activity of the pancreas is two-fold in character, and that the normal stimulus of secretin excites not only a breaking down of the protoplasm and a discharge of granules, but also a building up of the protoplasm and a new formation of granules. So marked, in fact, is this power of self-restitution that it is often advisable to diminish the resistance of the animal by bleeding or other means if it is desired to obtain a specimen of exhausted gland.

A study by Mr. Dale of the stages of exhaustion carried out in this way has brought to light a remarkable behaviour in the cells of the pancreas, to which we have no analogies in other secreting glands of the body. After the discharge of the granules the cells seem to undergo a still further involution, losing the whole of their chromophile substance, diminishing in size or undergoing vacuolation, and finally being transformed into cells undistinguishable from those which have long been known as forming the so-called "islets of Langerhans." Mr. Dale has, in fact, shown that in all probability these "islets," which are generally regarded as pre formed structures, really represent stages in the functional activity of the secreting cells of the gland, and he is of opinion that the activity of the gland is always associated with a cycle of changes in which the islets are formed, to be afterwards regenerated into secreting tissue. Other observers have noted in the embryo a development of secreting tubules from tissue undistinguishable from the "islets of Langerhans," and it is interesting to note that the depletion of the gland caused by long starvation has a similar effect to that caused by over-excitation, namely, the conversion of a large proportion of the gland tissue into "islet" tissue.

So far we have dealt only with the correlation of the activities of the cells lining the intestinal tube with those forming the masses of the pancreas and liver, and have seen that a very large part in this correlation is played by a chemical substance which acts, so to speak, as a chemical messenger between these various organs. A striking feature, however, of the pancreas is its alleged power of adapting its secretion to the nature of the food taken in by the animal. It has been stated by Pawlow that according as the food consists chiefly of proteids, carbohydrates, or fats, so do we find a relative preponderance of the ferments acting respectively on each of these three classes of foods. The evidence on which this statement is based, although lending to it considerable support, is not absolutely convincing. Vasilieff (*Archives des Sciences Biologiques*, St. Petersburg, 1893) examined the pancreatic juice of dogs which were fed on meat, or bread and milk alternately for periods extending over several weeks for each kind of diet. This observer found that the transition from bread and milk diet to a meat diet caused a rapid rise in the proteolytic power of the juice, which reached its maximum after several days of meat feeding. A return to a diet of bread and milk caused a slower fall in the proteolytic power of the juice, but a rise in the amylolytic power. Similar results were obtained by another pupil of Pawlow—Jablonsky (*ibid.*, 1896)—who also extended his observations to the fat-splitting ferment. At the time that these observations were made the function of enterokinase was unknown, and it is there-

fore impossible to say what proportion of the trypsinogen of the juice secreted in these experiments had been converted into trypsin by the small amount of intestinal mucous membrane at the mouth of the duct. While, therefore, we are unable to ascribe much importance to the results as regards the proteolytic power of the juice, there seems no reason to doubt the results obtained by these workers as regards the starch-digesting power of the juice. In 1899 Walther (*ibid.*, 1899, vol. vii. p. 1) made a series of observations on a dog with pancreatic fistula in order to determine whether the amounts of ferments secreted were determined by the nature of the food at any given meal. He was satisfied that his results showed that, even without prolonged adherence to one diet, the composition of pancreatic juice was adapted to the nature of the meal taken. His results do not entirely bear out his contentions, as is seen by the following table, in which it will be noticed that although milk contains no starch, it evokes the secretion of a large amount of amylopsin, and that meat causes a secretion of more steapsin than does milk, although this latter contains much more fat than the meat diet.

TABLE I.—*Results of Walther's Experiments.*

Diet	Total amount of enzyme secreted		
	Proteolytic	Amylolytic	Fat-splitting
600 c.c. milk ...	1044	2310	4125
250 grams bread ...	2360	6343	1218
100 grams meat ...	1720	2498	4410

Of course Walther, as well as the other observers mentioned, regard the adaptation as determined by the stimulation of special nerve endings in the mucous membrane by each constituent of the food, a conclusion hardly borne out by the results just quoted. Another disturbing factor in these experiments is the large variation in total quantity of juice secreted with different food-stuffs.

TABLE II.—*Amount of Pancreatic Juice Secreted for different Food-stuffs (Walther).*

Food	Hours of secretion									Total amount
	1	2	3	4	5	6	7	8	9	
600 c.c. milk	8·2	6·0	23·0	6·2	1·75	—	—	—	—	45 c.c.
250 grams bread ...	35·5	47·0	20·5	16·5	10·0	12·0	6·5	3·0	—	151 ,,
100 grams meat ...	45·0	52·0	35·0	9·75	—	—	—	—	—	142 ,,

The quantity of juice secreted will depend on the amount of secretin turned into the circulation, and this, in its turn, on the amount of acid entering the duodenum from the stomach. The amount of juice will, therefore, be measured by the stay and resistance to digestion of the substance in the stomach rather than to any direct nervous or other influence of the duodenal contents on the pancreas. A repetition of Walther's experiments by Popielski (*Centralblatt f. Physiologie*, vol. xvii., 1903), working independently, has in fact led the latter to deny altogether the adaptation of the pancreatic juice to the nature of the food. Popielski concludes from his experiments that variations in the juice depend only on the intensity and duration of the stimulus, the intensity of the stimulus determining the amount of enzymes, whilst its duration determines the total quantity of juice.

In the meantime the question had been attacked from another side. It had been shown by Fischer and Niebel (*Sitzungsberichte der K. Preuss. Akad. d. Wiss.*, 1895, p. 73), as well as by Portier (*C. R. Soc. de Biologie*, 1898, p. 387), that watery extracts of the pancreas of the cow, horse, and dog had no influence on lactose. Weinland in 1899 confirmed these results so far as concerns the pancreas of dogs on an ordinary diet free from milk. On the other hand, he found that extracts of the pancreas of dogs, which had been fed for several days on milk, sometimes with the addition of lactose, invariably contained lactase in considerable amount, and these results have been confirmed lately by Bainbridge working in our laboratory. Here then we have a definite instance of adaptation of the pancreas, the pancreatic juice or pancreatic extracts of dogs on normal diet containing no lactase, while the administration of lactose to these animals causes the appearance of lactase in both cases. Since in this case we have to determine, not simply an increase or diminution in the amounts of ferments always present in the juice, but the presence or absence of a definite substance, this was evidently the best starting point for an investigation of the mechanism by which the pancreas can adapt itself to the nature of the food, an investigation which has been carried out and completed by Dr. Bainbridge.

What are the limiting conditions? In the first place the reaction is absolutely specific. Unless the animal is taking lactose in its diet no lactase is ever found in the pancreas or in its secretion. The pancreas of new-born animals, for instance, is quite free from lactase, which, however, makes its appearance two or three days after birth as the result of the milk diet. The production of lactase is not a direct reaction of the pancreas to the presence of lactose in the blood, since subcutaneous or intravenous injection of lactose does not cause the appearance of lactase in the pancreas. The intestinal mucous membrane of all animals, whether on a milk diet or not, contains lactase and has an inverting action on lactose. It might be thought therefore that the production of lactase by the pancreas was a reaction to the presence of the products of inversion of lactose in the blood. This was found not to be the case. Subcutaneous injection of galactose for several days was not followed by any appearance of lactase in the pancreas or its juice. Nor was the appearance of lactase due to the increased production of this ferment in the mucous membrane, and its escape into the blood. Injection of an extract of mucous membrane rich in lactase, repeated several days in succession, was not followed by any appearance of lactase in the pancreas. Injection of lactose into the duodenum, and the subsequent injection of secretin after an interval of one hour, was inefficacious in causing the appearance of lactase in the pancreatic juice. For the production of lactase in the pancreas, or its juice, it is therefore necessary that lactose should act on the intestinal mucous membrane for some time. The reaction is a slow one, like the adaptation in Vasilieff's experiments, and is certainly not due to the stimulation of certain nerve endings in the mucous membrane by the lactose.

The problem was somewhat similar to that presented by the action of acid in the duodenum, since this introduced into the duodenum produces secretion of juice, whereas, when introduced into the blood stream, it has no effect whatever on the pancreas. The question suggested itself whether, under the influence of lactose, a special secretin was formed in the intestinal mucous membrane which, on access to general circulation, evoked the formation and secretion of lactase by the pancreas. Secretin was therefore made in the usual way (*i.e.* acidification, boiling, neutralisation, and filtering) from the mucous membrane of milk-fed dogs. The secretion evoked by the injection of this liquid resembled that obtained from the injection of ordinary secretin, and contained no lactase.

Yet it was evident from the results already obtained that lactose must act on the pancreas through the mucous membrane of the intestine. An extract was therefore made from the mucous membrane of the whole small intestine of a milk-fed dog. This was filtered through muslin, and about 10 c.c. injected subcutaneously into a biscuit-fed dog once a day for three days. The dog was then anæsthetised, a cannula placed in its pancreatic duct, and ordinary secretin injected. A flow of pancreatic juice was obtained, and this juice was found to contain lactase. This experiment was performed eight times, and in each case the juice obtained from a biscuit-fed dog which had been injected with an extract of the mucous membrane of a milk-fed dog contained lactase.

TABLE III.—*Effect on Milk Sugar of Pancreatic Juice from "Biscuit-fed" dogs, which had received Subcutaneous Injections during three days of Extracts of the Mucous Membrane of "Milk-fed" dogs.*

The figures represent c.c. of lactose solution which reduced 50 c.c. Pavy's solution.

Exp.	Controls: Solution of lactose	Controls: Lactose+pancreatic juice (boiled)	Lactose+pancreatic juice	Percentage of inversion
1 ...	7·4	...	6·8	18·1
2 ...	8·2	8·2	7·6	16·5
3 ...	8·2	8·15	7·85	9·7
4 ...	7·95	7·9	7·65	8·5
5 ...	7·8	..	7·5	8·8
6 ...	7·0	7·05	6·75	8·1
7 ...	4·1	...	3·75	20·8
8 ...	9·25	...	8·2	25·9

Here then at last we have some glimpse into the mechanism of the adaptation of the pancreas to the nature of the food. As the result of injection of lactose some substance which we may call x is produced in the mucous membrane of the small intestine. This substance is carried by the blood to the pancreas, and there slowly gives rise to the formation of lactase which is turned out in the juice when secretion is excited by the entry of acid chyme into the duodenum. We have no knowledge as yet as to the nature of this substance x. All we can say is that it is destroyed at a boiling temperature, since boiled extracts of the mucous membrane of milk-fed dogs do not, when subcutaneously injected, cause the appearance of any lactase in the pancreatic juice of biscuit-fed dogs.

Whether the qualitative adaptation of the juice in respect of its trypsin, amylopsin, and steapsin is carried out in a similar fashion we cannot as yet say. We hope that an investigation of the mechanism of this adaptation, which is now proceeding, may throw light, not only on the factors involved, but also on the nature of the substance which is formed in the mucous membrane, and has this marked effect on the activity of the pancreatic cells. Involving, as it does, two distinct sets of cells, this chemical adaptation is more complex than any yet investigated, and shows the intimate relation which must exist between the chemical activities of very different organs of the body.

THE ROYAL SOCIETY CONVERSAZIONE.

THE Royal Society conversazione was held in the rooms of the Society at Burlington House on Friday last, May 13. Many exhibits illustrating methods and results of recent scientific progress were on view, and are briefly described in the following abstract of the official catalogue. So far as possible the exhibits representing related subjects are here grouped together.

In the course of the evening, lantern demonstrations were given in the meeting room of the society. Prof. W. A. Herdman gave an account of the recent investigation of the Ceylon pearl fisheries; Mr. Francis Fox showed lantern slides, illustrative of (1) operations at the Simplon Tunnel; (2) the Victoria Falls and gorge of the River Zambesi, and proposed bridge; and the Hon. C. A. Parsons, F.R.S., gave a demonstration of the auxetophone. This instrument is an air operated valve which is used for a reproducer in gramophones and phonographs, and replaces the usual reproducing diaphragm in such machines. The application of this valve to the violin was shown, selections of music, vocal and instrumental, being played on the auxetophone.

The following is a classified list of the other exhibits:—

The differentiator, a machine recording as a curve the values of the rate of change of any variable quantity which can be represented by a curve: Dr. J. Erskine-Murray. When the machine is guided along any curve it automatically traces another which represents the rate of change of the quantity represented by the first curve. Thus, if the population of a country at various dates be plotted on paper the derived curve shows the rate at which the population is increasing or decreasing at every date during the period chosen.—Twin-elliptic figures showing change of phase in one or both ellipses: Mr. Joseph Goold.—A radial area-scale: Mr. R. W. K. Edwards. A contrivance for finding the area of a plane figure by means of a transparency.

Sensitive barograph, for the study of minor variations of atmospheric pressure: Dr. W. N. Shaw, F.R.S. The instrument shows the details of comparatively rapid fluctuations of pressure such as are often indicated in the barometric diagram of the *Times*.—(1) Traces obtained from self-recording instruments sent up by means of kites, (2) self-recording instruments from which the traces were obtained: Mr. W. H. Dines. In the recording instruments designed by M. Teisserenc de Bort, the height is obtained from an exhausted aneroid box, and the temperature from a Bourdon tube. In the recording instruments designed by the exhibitor, the height is obtained from a fair sized aneroid box of thin metal containing air. A temperature correction is necessary, but the position of the pen is dependent on the elasticity of the enclosed air.—Photographs of clouds: Commander D. Wilson-Barker.—Models and photographs of large hailstones: the Royal Meteorological Society.

Photographs and diagrams illustrating solar and meteorological changes, and a series of photographs to determine the relative temperatures of the stars: Sir J. Norman Lockyer, K.C.B., F.R.S. The exhibit illustrated (1) enlarged pictures of the sun in "K" light taken with the spectroheliograph of the Solar Physics Observatory. (2) The results of a discussion of sun-spot distribution. (3) The relationship between the positions of solar prominences and the different forms of the corona. (4) The different types, and their distribution, of the short period barometric pressure variation over the earth's surface. (5) The close connection between the change of barometric pressure and rainfall. (6) Series of photographs taken with a quartz-calcite prismatic camera of 2 inches aperture and 18 inches focal length to determine the relative temperatures of stars.—The Narraburra siderite, New South Wales: Prof. A. Liversidge, F.R.S. This exhibit included photographs of the siderite, and photographs of etched sections to show the changes in the internal structure. The composition of the siderite was:—iron 88·605, nickel 9·741, cobalt 0·474, copper 0·009, phosphorus 0·429, sulphur traces, resinous matter 0·008, insoluble in HCl. 0·720=99·906. Traces of gold and of the platinum metals appeared also to be present.—Transparencies and prints in illustration of a photographic atlas of the heavens; photographed at the Royal Observatory, Cape Town, 1903-4: Mr. J. Franklin-Adams.—Ten transparencies from negatives taken with the Rumford spectroheliograph of the Yerkes Observatory by Prof. G. E. Hale and Mr. F. Ellerman: the Royal Astronomical Society.

Examples showing the application of natural colour photography to the production of lantern slides of spectra for lecture and educational purposes: Mr. E. Sanger-Shepherd. Negatives are taken through three colour filters, admitting light of the three primary colour sensations—red, green and blue-violet, in accordance with the power of the respective sensations to excite the eye. From these negatives gelatin relief prints are made upon a special film, each relief being soaked in a water-colour ink of the complementary colour to the sensation which it represents. These reliefs whilst still wet are successively applied to a mordanted gelatinised glass plate. The inks transfer to the mordanted gelatin film, and the result is a natural colour photograph, consisting of nothing but the colouring matter securely locked up in a single film of gelatin.—Colour photographs shown by spectrum colours: Sir W. de W. Abney, K.C.B., F.R.S. The ordinary three-colour photographs are shown in a triple lantern, one image being tinted by the light coming through red glass, another by that through green glass, and the third by that through blue glass. The new method substitutes spectrum colours for the three glasses, with the result that the colours on the screen are much purer and truer.—High power microscopy: Mr. J. W. Gordon. The apparatus consists of a compounding drawtube and oscillating screen, as proposed in Mr. J. W. Gordon's paper on the Helmholtz

theory of the microscope, recently read before the Royal Microscopical Society. The object exhibited was a diatom (*Pleurosigma angulatum*) magnified about 10,000 diameters.—A cylindrical telescope for the rotation of images: Dr. G. J. Burch, F.R.S. This instrument consists of two cylindrical lenses with their axes of curvature parallel, fixed the sum of their focal lengths apart. Objects seen through it are not magnified, but reversed as by reflection in a mirror. If the telescope is rotated it causes the image to rotate with double the angular velocity.—Large direct vision spectroscope, with ten prisms, automatically adjustable: Mr. P. Heele.—Experiments with non-homocentric pencils: Mr. W. Bennett.—Optical testing bench: Messrs. R. and J. Beck. The bench is so designed that the optical constants of a lens and its various aberrations (chromatic, spherical, astigmatic, &c.) can be rapidly and accurately measured, and is specially adapted for using the new Hartmann system of testing either by direct vision or by photography.—Examples of photomicrography: Mr. Arthur E. Smith and Mr. Richard Kerr.

Some new phosphorescent materials: Mr. H. Jackson. Examples were shown of phosphorescent compounds of zinc, strontium, aluminium, calcium, &c., prepared to illustrate varying degrees of response to such exciting influences as violet and ultra-violet light, electric discharge, heat and friction. By varying the constitution of the compounds in the direction of increasing or diminishing their basic or acidic character the length of time during which the phosphorescent glow lasts can be increased or lessened considerably, and the property of glowing, when heated, can be made to persist apparently indefinitely.—Photographs illustrative of induced radio-activity of bacteria: Dr. Alan B. Green. Small masses of bacterial growth were exposed to the β and γ rays of 10 mg. of virtually pure radium bromide. In a large number of instances such masses when removed from the influence of the radium and placed between two thin sheets of glass, themselves not radio-active, were capable of so affecting the sensitised film of a photographic plate with which they were brought in contact, that on development in the ordinary way, the plate showed a dark area corresponding to the shape of the bacterial mass. The photo-actinic rays proceeding from the bacteria which had been exposed to radium were capable of affecting a photographic plate through a double layer of lead foil.

A method of mechanically reinforcing sounds: Mr. T. C. Porter. An ordinary "Home" Edison-Bell phonograph with the "reproducer" is used as the source of the sounds. In this instrument the roughness of the record makes a rod vibrate, and these vibrations are communicated mechanically to a thin disc of glass or mica, which in turn transmits them to the air on the side of the disc remote from the rod; the aërial disturbances are then conducted by a tube usually to a trumpet, but in this experiment the reinforcement of the sounds is obtained by the combustion of coal-gas and air. The mixed gases are led over the disc of the "reproducer" and conveyed by tubing to two convergent jets and then ignited. A further reinforcement is obtained by placing platinum foil in the flame.—Experiments on lubrication showing cavitation: Mr. S. Skinner. The lubricating fluid in the space, between a bearing and the axle working in it, is subject to conditions in which cavitation, *i.e.* the formation of vacuous spaces in the fluid, can occur. This was shown by a series of experiments, in which the deeply coloured lubricating fluid is contained between glass surfaces, and light is transmitted through the cavities.—(1) Microphone-buzzer (with partially tuned telephone) giving a nearly pure note of 2000 vibrations per second; (2) apparatus used to investigate the distribution of temperature in the field coils of electric machinery; (3) apparatus for rapid electric thermometry: the National Physical Laboratory.—(1) Vibrograph for recording vibrations photographically; (2) micro-manometer: the Cambridge Scientific Instrument Company, Ltd.—Stream gauge for indicating the rate of delivery of air or gas by a pipe: Mr. R. Threlfall, F.R.S.—(1) Stereoscopic views and specimens illustrating the construction of the Simplon Tunnel; (2) stereoscopic and other views of the Victoria Falls of the River Zambesi: Mr. Francis Fox.

Apparatus for the metrical study of stationary electric waves on spiral wires: Prof. J. A. Fleming, F.R.S. The apparatus exhibited consists of a long solenoid of silk-covered wire having 5000 turns and a total length of 643 metres. This solenoid has parallel to it an adjustable earth wire and a divided scale. The solenoid is connected to one point on an oscillatory electric circuit consisting of a couple of Leydens having a capacity of 0·00068 mfd. and an adjustable inductance of 0 to 230 microhenrys and a silent discharger. When oscillations are set up in this circuit by induction coil discharges and the frequency adjusted, stationary electric waves are set up in the solenoid. The position of the loops and nodes is ascertained by the use of a series of carbonic dioxide vacuum tubes.—Edison's secondary battery (or accumulator) for automobiles: Mr. W. Hibbert and Mr. H. E. Dick.—Electrical instruments of precision: Colonel R. E. Crompton, C.B.—Improved muffle and melting furnaces for use in laboratories or art studios: Mr. H. H. Cunynghame, C.B. The plan on which these furnaces are constructed is to jacket them thickly with non-conducting material, in such a way that heat cannot escape as fast as it is developed, until a high temperature has been attained.—Electric resistance furnaces for laboratory use: Mr. Bertram Blount.

Specimens illustrating the action that occurs between metals at a temperature many hundreds of degrees below their melting point: Mr. Sherard Cowper-Coles.—Apparatus for determining the ignition point of gases: Prof. H. B. Dixon, F.R.S., and Mr. G. W. A. Foster.—Specimens of methyl and other derivatives of sulphur, selenium and tellurium: Dr. A. Scott, F.R.S.

(1) A new natural order of plants, the Amphipterygiaceæ, Hemsley and Rose; (2) fruits of *Melocanna bambusoides*, an exalbuminous, viviparous bamboo; (3) *Hydnophytum longifolium* (Rubiaceæ), Fiji Islands; (4) *Dischidia rafflesiana* (Asclepiadaceæ), Malaya; (5) *Aspidium anomalum*, Ceylon: the Director, Royal Botanic Gardens, Kew.—(1) Specimens illustrative of cotton cultivation in British colonies and dependencies; (2) map showing the "cotton belt" and the British and foreign areas in which cotton is now commercially or experimentally cultivated (from Prof. Dunstan's report on cotton cultivation in the British Empire and Egypt); (3) mineral and rock specimens from Ceylon and southern Nigeria; (4) specimens of the seeds of *Hevea brasiliensis* (Para rubber tree) from the Straits Settlements: Prof. Wyndham R. Dunstan, F.R.S., director of the Imperial Institute.—Microscopic slides illustrating nuclear division in cells of malignant growths of man: Prof. J. B. Farmer, F.R.S., Mr. J. E. S. Moore and Mr. C. E. Walker.—Microscopic preparations illustrating the parasitism of the rust fungi or Uredineæ: Prof. H. Marshall Ward, F.R.S.—Microscopical preparations to show the fertilisation and alternation of generations in the Uredineæ: Mr. V. H. Blackman.—Plants and photographs from the High Andes of Bolivia and Peru: Mr. A. W. Hill.—A series of hybrid wheats illustrating Mendel's laws: Mr. R. H. Biffen.

The pearl-oyster fisheries of Ceylon: Prof. W. A. Herdman, F.R.S.—Microscopical preparations and diagrams of the chromatophores of the higher Crustacea: Mr. Frederick Keeble and Mr. F. W. Gamble. The coloration of such Crustacea as *Hippolyte varians* is due to pigments contained in chromatophores. The chromatophores consist of several compartments, in each of which a single pigment is present. When contracted to the centre of the chromatophore, a pigment plays no part in the coloration of the animal; when expanded into the superficial network which communicates with the centre, the pigment takes a share in the coloration.—Ticks and tick-transmitted diseases: Dr. G. H. F. Nuttall, F.R.S. The exhibit included specimens of ticks which transmit several diseases; also specimens of the parasites and figures.—Nematocysts of Æolids: Mr. G. H. Grosvenor.—International North Sea investigations. Results of work during 1903, from the Plymouth and Lowestoft laboratories: the Marine Biological Association.

A photographic study of the English skull, 1600–1850: Prof. Karl Pearson, F.R.S. The photographs of English skulls illustrated normal and abnormal types. There were two series, numbering upwards of 500 altogether, from old plague pits or graveyards in the City of London. Both series were of great interest, and the nearest related group to one of them appears to be long barrow British.—Apparatus and methods employed for measuring, in the

case of human blood, its content in agglutinating substances, bactericidal substances, red blood corpuscles, albuminous substances, calcium salts, and salts generally: Dr. A. E. Wright.—(1) Wax model of the marmoset's brain; (2) sections from which the wax model was constructed: Mr. Gustav Mann.

(1) Colour printed geological maps; (2) geological model of the Isle of Purbeck: the director of the Geological Survey and Museum.—Models illustrative of mountain building: Lord Avebury, F.R.S.—(1) A set of lantern slides of microscopic sections of igneous rocks, &c.; (2) portable sounding machine for mountain lakes: Prof. E. J. Garwood. —Series of geological and other drawings and plans: Prof. J. P. O'Reilly.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—In connection with the approaching international assembly of representatives of academies, it is proposed to confer the degree of Doctor of Science *honoris causa* on Prof. Bakhuyzen, of Leyden; Dr. Faminstyn, of St. Petersburg; Dr. Mojsisovics von Mojsvár, of Vienna; Prof. Retzius, of Stockholm; Prof. Riecke, of Göttingen; and Prof. Waldeyer, of Berlin; and the degree of Doctor of Letters *honoris causa* on Count de Franqueville, of Paris; Prof. Goldziher, of Budapest; Prof. Gomperz, of Vienna; Prof. Krumbacher, of Munich; Prof. Leroy-Beaulieu, of Paris; and Dr. Perrot, of Paris.

Mr. W. J. Sell, F.R.S., and Mr. H. J. H. Fenton, F.R.S., are to be appointed university lecturers in chemistry, and Mr. A. Harker, F.R.S., a university lecturer in petrology.

The Senate of the Royal University of Ireland has resolved to confer, *honoris causa*, the degree of Doctor of Science on Sir William Crookes and on Prof. J. Dewar.

Science states that the New York University has received an anonymous gift of 2500*l.* for the Medical College, and that the American Geographical Society has received a bequest of 6000*l.* from Sarah M. de Vaugrigneuse.

In a paper on "Local Expenditure and Local Indebtedness in England and Wales," read by Mr. R. J. Thompson at the Royal Statistical Society on Tuesday, it was stated that education showed an increase of expenditure from 4,806,000*l.* in 1889 to a sum of nearly 11,000,000*l.* in 1902. The cost of erecting school buildings had during the same time—1889 onwards—augmented the outstanding loans from 9,937,000*l.* to 33,564,000*l.* London incurred 29 per cent. of the total expenditure, while it contributed only one-fifth of the total number of pupils.

The inauguration on February 10 of an information bureau in connection with the University of Paris is an excellent innovation. The bureau will afford information on all matters connected with higher education in Paris, whether in Government or private institutions. Those who in this country are contemplating entering a university, and who have spent hours in trying to derive some tangible ideas from calendars and class syllabuses, will appreciate the useful purpose which would be served by a bureau of this character. If such a bureau would go a little further, and furnish to candidates for chairs and lectureships some idea of the duties they would have to perform, its value will be still greater.

The President of the Board of Education, the Marquess of Londonderry, K.G., has appointed a departmental committee to inquire into the present working of the Royal College of Science, including the School of Mines, to consider in what manner the staff, together with the buildings and appliances now in occupation or in course of construction, may be utilised to the fullest extent for the promotion of higher scientific studies in connection with the work of existing or projected institutions for instruction of the same character in the metropolis or elsewhere, and to report on any changes which may be desirable in order to carry out such recommendations as they may make. Sir Francis Mowatt, G.C.B., is chairman of the committee, and Mr. J. C. G. Sykes, assistant secretary in the branch of the board which deals with evening schools, technology, and higher education in science and art, has been appointed secretary to the committee. The London County Council is represented on the committee.

A deputation consisting of representatives of various county councils was received by Sir William Anson on May 13 with reference to the abrogation of the arrangements which were in vogue under what was known as Clause 7 of the Directory of the Science and Art Department. The deputation explained that county councils had hoped when the Education Act became law that it would be recognised more fully than before that these councils were the authorities for all grades of education, including particularly higher education. But the new regulations taking the place of Clause 7 have reduced their powers, and county councils are hampered in the performance of the duties expected of them. In reply, Sir William Anson explained that Clause 7 was an attempt to bring local authorities into relations with the efforts being made to give science and art and technical teaching, assisted by the Board of Education, and limited in the first instance to institutions of a very different character from ordinary secondary schools. Local authorities are now in a position to deal with the whole of secondary education, and not merely with the subject-matter which was contemplated in Regulation 7. Sir William Anson, in conclusion, asked the deputation to consider the wider question which they should have in view in dealing with secondary education, and not merely from the point of view of exercising their own authority and the speedy transaction of their own business. What he deprecated was that at that early stage in the working of the Act, the Board of Education should be asked to stereotype the relations of local authorities for the secondary schools within their area.

At the annual conversazione of the Medical Society of London on Monday, Sir Isambard Owen delivered the annual oration, taking for his subject "The Future of London Medical Education." After contrasting the interest displayed by Continental States in scientific research and public education with the indifference evinced towards them by the generality of Englishmen, and pointing out that this indifference could only be a passing phase, due to patent historical causes, he expressed the hope that the reports of the Mosely Commissioners, with their marvellous tale of recent educational progress in America and the fabulous amounts of public and private money freely lavished upon it, would at last awaken attention here to the backward state of things at the heart of the British Empire. Of all forms of higher education, he submitted, none could lay greater claim to public support than medical education. The unendowed London schools had still to carry the entire burden of the preliminary academic training of their students—a task which elsewhere was now undertaken by endowed universities and university colleges. Until the reconstitution of the University of London, no practicable way out of the difficulty could be seen. Sir Isambard Owen then detailed the plan which the university had adopted of establishing a public institute within its bounds and under its direct control to undertake teaching in physics, chemistry, biology, anatomy, and physiology for the purposes of medical students. Including buildings, the institute would cost about 375,000*l.* to establish. As the State declined all responsibility for professional education in England, the university could only look to enlightened private liberality. Wealthy men in London capable of being fired by emulation of Transatlantic gifts to education should make this modest benefaction their peculiar care.

SOCIETIES AND ACADEMIES.

London.

Anthropological Institute, April 26.—Sir Thomas Holdich, K.C.M.G., &c., in the chair.—Prof. W. **Ridgeway** delivered a lecture on the origin of jewellery. Prof. Ridgeway holds that the objects employed in modern jewellery had their origin in magical properties attributed to them and not in æsthetic, although the æsthetic reason for wearing them undoubtedly influenced the wearers at an early stage (see Nature, October 29, 1903, vol. lxviii. p. 636).

Challenger Society, April 27.—Sir John Murray in the chair.—Prof. **Minchin** exhibited specimens of the new sporozoan, *Lymphocystis johnstoni*.—Mr. E. T. **Browne** showed Medusæ from Valencia.—Dr. G. H. **Fowler** explained some graphic diagrams of the distribution of Biscayan Chætognatha, and announced that he had detected *Krohnia hamata* among specimens obtained at the Falkland Islands by Mr. Vallentin within six fathoms from the surface.—Mr. V. H. **Blackman** read a paper on the metabolism of the ocean, dealing with the close analogy between the circulation of nitrogen on land and that in the sea; this was followed by an interesting discussion.—Mr. G. P. **Farran** described the copepods of the north-east Atlantic slope; of these rather less than half present a wide and often tropical distribution, occurring also in the Indian or Pacific Oceans. The remainder are only known as Atlantic or Atlanto-Mediterranean species, many being bottom haunting forms, the recorded range of which is likely to be extended. About 12 per cent. of the total copepod fauna extends north to the Arctic regions.

British Academy, April 27.—Lord Reay, president, in the chair.—Prof. I. **Gollancz** read a paper on Shakespeariana, 1598–1602. A theory was put forward explanatory of Shakespeare's use of the name Polonius for the counsellor of the King of Denmark in place of Corambis, or Corambus, found in the first quarto, evidently the name of the character in the old play, which belonged to about the year 1587. Corambus, being discarded by Shakespeare, was used by him as a passing name in the play of "All's Well."

Physical Society, May 6.—Mr. J. Swinburne, vice-president, in the chair.—Some instruments for the measurement of large and small alternating currents: W. **Duddell**. The author, after some preliminary remarks on the available means for measuring alternating currents, proceeded to describe three thermal instruments which he has constructed for this purpose. The first instrument is essentially a sensitive Ayrton-Perry twisted strip ammeter which is very quick in action for a thermal instrument, and has been used for observing and recording P.D.'s and currents which varied as rapidly as one per second. The second instrument exhibited was a very sensitive thermal galvanometer called in the paper a "thermogalvanometer." It consists of the combination of a radio-micrometer of the "Boys" type with a very small resistance which is heated by the current to be measured, and in turn heats the thermojunction of the radio-micrometer by radiation and convection. The third instrument described was a switchboard instrument which works on the same principle as the last.—Mr. F. E. **Smith** exhibited and described the following instruments from the National Physical Laboratory:—(1) a mercury-resistance standard; (2) a 10-ohm build-up resistance-box; (3) an astatic galvanometer.

Mathematical Society, May 12.—Dr. E. W. Hobson, vice-president, in the chair.—The following papers were communicated:—On the evaluation of certain definite integrals by means of Gamma functions, and generalisations of Legendre's formula $KE'-(K-E)K'=\frac{1}{2}\pi$: A. L. **Dixon**. It has been shown by E. B. Elliott that Legendre's relation may be regarded as a particular case of a relation by which a certain sum of products of what are really hypergeometric functions can be expressed in terms of Gamma functions. In the Weierstrassian form of Legendre's relation, a certain determinant of the second order having elliptic integrals as its elements is shown to be a constant. In the generalisation the determinant is of order higher than the second, the elements are hyperelliptic integrals, and the constant is expressed as a product of Gamma functions. The ratio of two such determinants, of suitable orders, is expressed in a similar form. Weierstrass's relations between hyperelliptic integrals of the first and second kinds are deduced. The results are extended to include a certain class of integrals which are not integrals of algebraic functions.—Perpetuant syzygies: A. **Young** and P. W. **Wood**. The perpetuants considered are linear in the coefficients of each quantic concerned, that is to say, they are "perpetuant types." All possible products of irreducible forms of a given degree and weight are arranged in a predetermined sequence so that any product may be identified by its place in the sequence. A syzygy expresses one of the products that enters into it, viz. the one that comes earliest in the sequence, in terms of others which come later in the sequence. In consequence of the existence of the syzygy this earliest product is "reducible." It is possible to enumerate the actually irreducible forms for degree δ by means of a generating function. When the irreducible products have been identified for any degree, all the independent syzygies of this degree will have been identified, there being one such syzygy for each reducible product of irreducible forms. The work can be completed as far as degree 8, but a large class of products have been discussed in general. A generating function for all irreducible products and types of degree δ is suggested in the form

$$\frac{x^{\binom{\delta}{1}+\binom{\delta}{2}+\cdots+\binom{\delta}{\kappa}}}{(1-x)^{\delta-1}}$$

and this form is proved to hold for $\kappa=1$, $\kappa=2$ and $\kappa \geq \frac{1}{3}\delta$.—Note on the integration of linear differential equations: Dr. H. F. **Baker**.—Some properties of the function Γ_p: **Rev.** F. H. **Jackson**.—Informal communications were made as follows:—On the geometrical representation of imaginaries: G. B. **Mathews**.—A collation of Kessler's and Hertzer's tables of the residue-index (ν) of 10 (mod p) with Shanks's table of the Haupt exponent (ξ) of 10 (mod p): Lieut.-Colonel A. **Cunningham**. The numbers ν and ξ are defined by the congruence $10^{\xi}\equiv 1$ (mod $p=\nu\xi+1$). Twenty-nine errors were found in Kessler's table, 3 in Hertzer's, 107 in Shanks's.

CAMBRIDGE.

Philosophical Society, May 2.—Dr. Baker, president, in the chair.—Early development of the unfertilised egg of the sawfly *Nematus ribesii*: L. **Doncaster**. In the unfertilised egg the two maturation divisions give rise to four nuclei, the outer two of which are the halves of the first polar body, the third is the second polar nucleus, and the innermost the egg-nucleus. The second polar nucleus unites with the inner half of the first, giving the "copulation nucleus." This divides into two groups of chromosomes, which persist without important change until the blastoderm begins to form, beyond which stage their fate has not yet been followed. The egg-nucleus soon begins to divide, and gives rise to the embryo, the chromosomes remaining at the reduced number. The outer nucleus of the first polar body rapidly disappears. These results are very similar to those obtained by Petrunkewitsch in the bee, where, as in this case, virgin eggs produce males, and fertilised eggs females. It was pointed out that a comparative study of the development of sawflies which produce males and females respectively from virgin eggs would provide a test of Castle's hypothesis of sex-determination.—Metallic "passivity" in relation to time and temperature: Dr. W. A. **Hollis**.—(1) On partial fractions; (2) note on plane unicursal curves; (3) on the order of certain systems of conditions: Dr. A. C. **Dixon**.

PARIS.

Academy of Sciences, May 9.—M. Mascart in the chair.—The president announced to the academy the death of M. Duclaux, member of the section of rural economy, and gave a short account of his life work.—Remarks on the use of alternating currents in chemistry and on the theory of reactions which they set up: M. **Berthelot**. Remarks on the recent work of MM. Brochet and Petit concerning the solution of platinum in a solution of potassium cyanide by the action of an alternating current. The author directs attention to a similar reaction with glucose studied by him in 1879. The bearing of these experiments on the action of the silent discharge is also discussed.—The cooling power of a feebly conducting liquid current on an indefinite cylinder, the axis of which is normal to the current: J. **Boussinesq**.—On a new method of preparation of alkyl and alkylidene derivatives of cyclic ketones. The application to the preparation of alkyl-menthones: A. **Haller**. By treating certain cyclic ketones, such as menthone, with sodium, the corresponding alcohol is formed besides the sodium derivative, and in preparing alkyl derivatives this leads to undesirable secondary products. The formation of the alcohol is avoided if sodium amide is used instead of sodium, and the

alkyl iodide can be added directly to the reaction product. The physical properties of several homologues of menthone which have been prepared in this way are described.—An arrangement allowing identical results to be obtained with X-ray tubes on different occasions: M. **d'Arsonval.** The current passing through the tube is measured by means of a milliammeter of the d'Arsonval type. For a tube with a given vacuum, the amount of X-rays given off, as measured by their photographic effect, is proportional to the intensity of the current passing through the tube, and this appears to be true of various makes of tube.—M. Barrois was elected a member in the section of mineralogy in the place of the late M. Fouqué.—Observations of the Brooks comet (1904 *a*) made at the Observatory of Algiers with the 31·8 cm. bent equatorial: MM. **Rambaud** and **Sy.**—The linear *connexe* in space of $n-1$ dimensions: Léon **Autonne.**—On the radio-activity of gases given off from the water of thermal springs: P. **Curie** and A. **Laborde.** The radio-activity of samples of gas from various mineral waters was measured and its rate of decay determined, the results being compared with the radio-activity of air which had been in contact with a known amount of radium bromide. The radio-activity was in all cases very small, and it hardly appears possible to draw any conclusion as to the action the radio-activity may play in the physiological actions of mineral waters.—On the melting point of gold: Daniel **Berthelot.** It is pointed out that all the recent values for the melting point of gold fall between 1064° and 1067°.—On the fixity of the solar rays: Maurice **Hamy.** The author has previously shown that there is a slight variation in the wave-length of the λ 508 cadmium ray according as a tube with or without electrodes is employed. Since the physical conditions in the sun are liable to considerable variation at times, the question is raised as to how far the solar lines can be regarded as possessing absolutely fixed wave-lengths.—The proof of a radio-activity induced on all bodies by the emanation from incandescent metallic wires: Th. **Tommasina.**—The action of anæsthetics on the sources of the *n*-rays: Jean **Becquerel.**—On some points of technique for the examination of organs by means of the *n*-rays. First results relating to a study of the brain: André **Broca.**—On the mode of propagation of nervous oscillations: Augustin **Charpentier.**—Electrical osmosis in methyl alcohol: A. **Baudouin.**—On the atomic weight of samarium: G. **Urbain** and H. **Lacombe.** The samarium salts were obtained from three different sources, and atomic weight determinations of the various fractions, together with the spectroscopical examination, showed that the oxide was homogeneous. The final value for the atomic weight of samarium (O=16) is 150·34.—The formation of hydrogen silicide by direct synthesis from its elements: Ém. **Vigouroux.** Remarks on a recent paper by M. Dufour on the same subject.—The apparent volatilisation of silicon in hydrogen: A. **Dufour.** In Geissler tubes filled with hydrogen arsenide, the arsenic deposited by the discharge is displaced by distillation pure and simple; in tubes filled with hydrogen silicide, the displacement of the silicon under similar conditions is explained by the formation of hydrogen silicide in the warm parts of the tube and its decomposition in the dark space.—On a property of tin-aluminium alloys: Hector **Pécheux.**—The differentiation of the primary, secondary and tertiary alcohols of the fatty series: André **Kling** and Marcel **Viard.** The method adopted is based on the fact that tertiary alcohols are decomposed at the temperature of boiling naphthaline, whilst at the temperature of boiling anthracene only primary alcohols resist decomposition. The vapour density of the alcohol under examination is taken in a Victor Meyer apparatus with the above two liquids as vapour jackets, the deviation from the theoretical density showing to which class the alcohol belongs. About 250 determinations have been made by this method, a summary of which is given.—On the formation of the chloroanilines: Eyvind **Bœdtker.**—On the saponifying power of the castor oil seed: Maurice **Nicloux.**—On the structure of the heart in Cephalopods: F. **Marceau.**—The resistance of certain seeds to the action of absolute alcohol: Paul **Becquerel.** The tegument of the moist grain allowing of osmosis is permeable to absolute alcohol, but when dried to a certain extent, osmosis no longer takes place, and the skin is now absolutely impermeable to alcohol.

DIARY OF SOCIETIES.

THURSDAY, May 19.

Royal Society, at 4.30.—The Bakerian Lecture will be delivered by Prof. E. Rutherford, F.R.S., on the Succession of Changes in Radio-active Bodies.—The following papers will be read in title:—The Spectrum of the Emanation of Radium: Sir William Ramsay, K.C.B., F.R.S.—On Saturated Solutions: Earl of Berkeley.—On the Liquefied Hydrides of Phosphorus, Sulphur, and the Halogens, as Conducting Solvents. Part i.: B. D. Steele and D. McIntosh.—On the Liquefied Hydrides of Phosphorus, Sulphur, and the Halogens, as Conducting Solvents. Part ii.: D. McIntosh and E. H. Archibald.—On the General Theory of Integration: Dr. W. H. Young.

Institution of Mining and Metallurgy, at 8.—Miners' Phthisis—its Causes and Prevention: Dr. J. S. Haldane and R. A. Thomas.

Institution of Electrical Engineers, at 8.—Discussion on Messrs. Parsons, Stoney and Martin's paper, entitled The Steam Turbine as applied to Electrical Engineering.

FRIDAY, May 20.

Royal Institution, at 9.—The Radiation and Emanation from Radium: Prof. E. Rutherford, F.R.S.

TUESDAY, May 24.

Royal Institution, at 5.—The Solar Corona: H. F. Newall, F.R.S.

Linnean Society, at 8.—Anniversary Meeting.

WEDNESDAY, May 25.

Geological Society, at 8.—Occurrence of a Limestone with Upper Gault Fossils at Barnwell, near Cambridge: W. G. Fearnsides.—Age of the Llyn-Padarn Dykes: J. V. Elsden.

Victoria Institute, at 4.30.—The Tanganyika Problem: W. H. Hudleston, F.R.S.

THURSDAY, May 26.

Royal Institution, at 5.—Literature and the State: H. G. Wells.

Institution of Electrical Engineers, at 8.—Annual General Meeting.

FRIDAY, May 27.

Royal Institution, at 9.—The Progress of Oceanography: H.S.H. Albert Prince of Monaco.

Physical Society, at 5.—The Law of Action between Magnets and its bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers: Dr. C. Chree, F.R.S.—On the Ascertained Absence of Effects of Motion through the Ether in Relation to the Constitution of Matter on the FitzGerald-Lorentz Hypothesis: Prof. J. Larmor, Sec.R.S.—On Coherence and Recoherence: Dr. P. E. Shaw and C. A. B. Garrett.

SATURDAY, May 28.

Royal Institution, at 3.—Spitsbergen in the 17th Century: Sir W. Martin Conway.

CONTENTS.

THURSDAY, MAY 26, 1904.

STEPS TOWARDS A NEW PRINCIPIA.

Electricity and Matter. By Prof. J. J. Thomson. Pp. 162; with diagrams. (Westminster: Archibald Constable and Co., Ltd., 1904.) Price 5*s.* net.

IT is an interesting fact that the British Association is going so soon to meet, under distinguished presidency, at Cambridge, for there of late years has the most splendid work in pure physical science been done, and there it seems to me an erection comparable in some respects to the Principia is being raised. One of the foundation stones was laid in 1881 by J. J. Thomson in a mathematical paper on the motion of a charged sphere, a paper in which the idea of real electric inertia took tangible and tractable form. The building has been growing ever since, and is now in full process of construction, though I hope it will be long before its development shall cease or the work be regarded as finished and ready to be left to the admiration of future generations.

The little book which constitutes the subject-matter of this review embodies a set of six lectures delivered on the other side of the Atlantic, at the invitation of Yale University, last spring, by the Cavendish professor of physics at Cambridge, England.

They are not exactly popular, for although no mathematics is introduced beyond what ought to be (but usually is not) familiar to all who have been in the sixth form at a public school, yet the ideas are definite and quantitative, and are briefly expressed because they are addressed to persons with some knowledge of physics; moreover, they are such as can hardly be made so childishly simple as to be apprehended of the general average of so-called educated men in this country, whose sense-perceptions in the direction of great and comprehensive ideas have not been developed.

To students of physics and higher chemistry this book serves as a very readable digest and summary of what is to be found worked out in more detail in other writings by the same author; and those who have studied his most recent papers can hardly avoid reading back into this little volume, which can be skimmed at a sitting, much that has really been elaborated since, and some things which still await elaboration, on lines which are merely suggested here.

It is difficult to exaggerate the suggestiveness of the wealth of theory which is now being lavished upon us in the domain of atomic structure and the mathematics of chemistry; it appears likely to lead to a definite microcosmic astronomy, based upon the known properties of electric lines of force, akin to the welding together of the observed facts of the heavens by a single comprehensive law, and forming the basis of a real chemical "Principia."

The discovery on which everything depends is the recognition of the atom of electricity, a discovery to which no one man can lay claim, and superposed upon this a detection of the extraordinary properties belonging to an electric line of force, at rest, in motion, and under acceleration, which is again a development to which several have contributed. But it is safe to say that a great bulk of the treatment of the subject, both on its experimental and mathematical side, emanates, with a few important exceptions, in some form or other from Cambridge, and it is difficult to overestimate the force and suggestiveness with which ideas connected with the most recent and still nascent steps in theory are presented in this small book.

The book is in six chapters, corresponding apparently with six lectures.

Chapter iv., on the atomic structure of electricity, gives the customary account of the evidence for electric atoms, and for considering the charge on a corpuscle to be identical with the ionic charge of a hydrogen atom; the experiments by which these conclusions were reached in the Cavendish Laboratory being summarised and explained on the usual lines. First, it was shown that the conductivity of a gas depended on something that could be filtered out of it; next, the aggregate charge of the ions in a given volume of gas was determined by the method of the saturation current; then these ions were counted by the highly ingenious "cloud" method, and thus the charge on each determined. The value, it may be noted in passing, is rather higher than what used to be roughly estimated for this fundamental electric unit. Whereas it used to be guessed as about 10^{-11} electrostatic units, measurement seems to show that it is more nearly 3.4×10^{-10}; and, in order to make this quantity equal to the charge on a monad ion in electrolysis, the number of molecules in a cubic centimetre of gas, at standard temperature and pressure, must be rather fewer than used to be estimated as probable, and also rather definite, being about 3.6×10^{19}, which means 8×10^{23} atoms of hydrogen per gram.

A new confirmatory method applied by Dr. H. A. Wilson is described, in which the settling of a cloud under gravity is opposed by a measured electric field; and on this plan the same result is obtained. Also Prof. Townsend and Dr. H. A. Wilson, by applying electrolytic considerations and experiments to ionised air, were able to show directly that the ionic charges in all cases are really identical, and are the same as that familiar in electrolysis.

A rapid summary of the now well known methods by which the mass of the carriers for negative and for positive electricity respectively has been determined is also given, and it is pointed out how striking is the resemblance of the result to Franklin's one-fluid theory of electricity:—

"The 'electric fluid' of Franklin corresponds to an assemblage of corpuscles, negative electrification being a collection of these corpuscles. The transference of electrification from one place to another is effected by the motion of corpuscles from the place where there is a gain of positive electrification to the place where there is a gain of negative. A positively electrified body is one that has lost some of its corpuscles. We have seen that the mass and charge of the corpuscles have been determined directly by experiment. We in fact know more about the 'electric fluid' than we know about such fluids as air or water."

The next chapter (v.), on the constitution of the atom, begins still on familiar ground, and exhibits the evidence for the great intrinsic energy of electrically constituted atoms, and estimates the rate of radiation of energy from corpuscles variously distributed inside an atom, showing that the radiation from a single corpuscle is far greater than that to be expected from two or more, especially when their speeds are not excessive. [It may be observed that a pair of revolving electrons, at opposite ends of a diameter, will be equivalent to two equal opposite currents, and hence will tend to neutralise each other's influence at a distance, especially along the axis of revolution; unless indeed they are moving with the speed of light, in which case they could start the crest and trough of an advancing elliptically-polarised wave.] Hence a certain number of corpuscles are essential to the stability of an atom, a few would soon radiate their energy away; and this fact, on the doctrine of the evolution of matter, suggests a reason for the non-existence of permanent elements of lower atomic weight than hydrogen.

But a great deal more than that is made out towards the end of the chapter, where the electric constitution of the atom is applied to chemistry, and a beginning of the explanation of "the periodic law" is made in this chapter which is further developed by the author in a great paper in the March number of the *Philosophical Magazine* for the present year. Also the homologous series of lines in the spectrum, investigated by Rydberg, Runge and Paschen, and Kayser, is shown to be a fairly natural, or at least plausible, consequence of the groupings of various numbers of corpuscles or electrons inside an atom; though it must be admitted that unless attention is paid to the modern view that concussions and not regular motions are the real cause of perceptible visible radiation and line spectra, the theory remains obviously very incomplete. The mode in which the corpuscles would statically distribute themselves, if they were limited to a plane, under the combined action of a mutual inverse square repelling force and a direct-distance central attracting force, is treated much as Lord Kelvin had already treated it in his remarkable paper called "Æpinus atomized" (reprinted as an appendix in his Baltimore Lectures), and is illustrated by Alfred Mayer's experiments on floating magnets; and the deductions, although plainly only the nucleus of an investigation, are already very suggestive and promising. In the March *Philosophical Magazine* the investigation into the stability of moving electrons is carried much further, and a distinct step is made in mathematical chemistry.

One very simple and important remark is made near the end of chapter v. concerning the "bonds" of the chemist, which, being I suppose universally recognised as Faraday lines of electric force, must differ from ordinary stretched elastics in having opposite properties at the two ends. The bonds, in fact, must have "sense" as well as direction, they are not simple links; and hence when carbon atoms are linked together those atoms cannot really have identical properties, unless indeed they are linked to each other by an even number of bonds. Incidentally it becomes clear at any rate in the March *Phil Mag.* it becomes clear to me—why carbon or tetrad atoms can link themselves into complex molecules: the foundation of organic chemistry.

A suggestion is also made concerning certain "additive" properties, such as the refractive power of different substances for light, which students of physical chemistry will do well to take up and press further.

The obvious question as to how an electrically constituted atom can acquire an additional charge, so as to become an ion, either positive or negative, and either monad, dyad, or triad, is discussed, and a guess is made as to the nature of molecular combination. It is also attempted to explain why a liquid, say liquid mercury, is so immensely better a conductor than mercury vapour, and why some gases may be conductors and others not. The violent motion of corpuscles going on inside an atom is styled by J. J. Thomson the "corpuscular temperature" of the atom, which may or may not be a convenient term; the ordinary temperature of the gas, called "molecular temperature," is generally very much smaller, and has no apparent relation with the corpuscular temperature. By the interaction of these two temperatures on one another, an attempt is made to account for certain chemical facts of combination. The whole of the chapter is so concentrated and full of suggestion that it is impossible effectively to abstract it further. What I wish to indicate to students is the desirability of studying the original.

Prof. Poynting has on this point made a remark to me which he permits me to incorporate, viz., that at high molecular temperatures there must be some distinct correspondence between molecular and corpuscular temperatures. For in the sun corpuscles are set free by collisions [as they may also be set free by the clash of chemical combination at more ordinary temperatures, a bright line spectrum resulting in both cases from the perturbation of those corpuscles which, although shocked, escape separation]. There would appear to be some high temperature at which the atoms go to pieces—a limiting molecular temperature beyond which they cannot exist (an atomic dissociation temperature), not *much* higher probably than the solar temperature. It is worthy of remark that no star is much hotter than the sun: possibly none so high as ten thousand degrees centigrade. If not, why not? unless it be because there is a natural limit at which matter goes to pieces.

The final chapter, on radio-activity and radio-active substances, emphasises the way in which atomic collapse, or re-distribution of corpuscles—a sort of atomic earthquake—may occasionally occur, after the radiation of a certain amount of energy has gone on for some time, by spontaneous re-arrangement of the constituents into a more stable form. For since orbital motion plainly tends to increase stability, enabling a greater number of corpuscles to resist central attraction than could hold out if they were stationary, it follows that, as the corpuscles slow down, they may at certain critical stages find it necessary to fall into

an allotropic modification of the element, or else to expel some and re-arrange the remainder; the analogy being a spinning top which tumbles over when its velocity falls below a certain critical value. [Some varieties of "new star" may conceivably furnish another and different kind of analogy.]

A new suggestion also is made with respect to Röntgen rays, viz. that they may sometimes precipitate atomic disintegration and thus cause a substance to emit more energy than they themselves contain. It is also pointed out in a previous chapter how a shell of Röntgen radiation will not disturb particles over which it passes if it is below a certain thickness, but if thicker than that will communicate momentum to them; and in that way a kind of modified Le Sage's gravitation hypothesis is suggested, not, however, in a convincing manner, but rather as one of the possibilities that have to be discussed, and after further consideration probably abandoned. At the same time, the hypothesis concerning radium favoured by Lord Kelvin, viz. the reception of energy from a store of cosmic waves and the consequent production of radioactivity, is shown to be in many respects feasible, though taken all round unlikely and rather artificial.

But the most remarkable and novel portion of the book is the use made of Faraday's lines of force, and the great development and importance attached to them, in the first three chapters. Strangely enough, these lines are for the first time regarded as realities; no longer as a mere map of a state of things which is essentially continuous, but as an actual fibrous structure attributable to an electric field, and therefore also to a magnetic field, and therefore also to radiation. The lines of force are not only *like* elastic threads which repel each other, but really are such threads, though with varying thickness and with their tension everywhere proportional to their cross-section; and it seems possible to think of them as vortex filaments, thus reproducing in many respects FitzGerald's conception of a fibrous vortex ether consisting of filamental or cobweb vortices interlaced in every direction (see preface to "Modern Views of Electricity," 1889), only these do not become lines of force unless they are cut and terminated; the newer view regards the place where their intense ends terminate as a negatively charged corpuscle or electron, their wider opposite ends appearing to correspond with positive electricity, the nature of which, however, still remains a close secret. This seems to be J. J. Thomson's view—though it is not clear that he regards the vorticity as anything more than an analogy his view is that the lines of force or vortex fibres actually exist, radiating from corpuscles, constituting electric lines of force, generating magnetic fields when they move, and conferring mass on the particle by reason of the amount of ether entangled inextricably in each filament; and he shows further how, when the fibres are accelerated, especially when they are suddenly started or stopped, a much more intense local magnetic field for a moment makes its appearance and rapidly spreads out as a wave of radiation, by reaction with the superposed electric field, just as Larmor and others have calculated, and of course in accordance with Poynting's theorem.

The whole treatment here, with simple geometrical conceptions, is exceptionally interesting; and the resulting view of the nature of light—that it consists, as it were, of pulses running along the fibres as along stretched strings, with constant speed because their tension is proportional to their mass per unit length—is especially noteworthy, and is quite in accordance with a guess which the genius of Faraday enabled him to throw out in his famous "Thoughts on Ray Vibrations," where he says:—

"The view which I am so bold as to put forward considers therefore radiations as a high species of vibration in the lines of force which are known to connect particles and also masses together."

It is clear that if this vibrating string method of regarding waves of light be substantiated, a wave front cannot be a continuous surface, but must be, as it were, a series of isolated specks of disturbance; so also must a Röntgen pulse, and hence J. J. Thomson is able to reconcile with theory the actually experienced small ionising power of such waves, as compared with what might be expected if they really and necessarily encountered every atom in the field. They would, on the fibrous view, be in some respects more akin to a stream of kathode rays penetrating between the actual corpuscular particles of matter, and only encountering them occasionally, just as a comet or meteoric stone only occasionally encounters a planet.

One of the interesting features of the book—though it is also contained in another volume by the same author, "The Conduction of Electricity by Gases"—is the summary of a re-calculation of the results of Kaufmann's excellent experiments on the magnetic deflection of flying particles moving with very high velocity, such as can be shot off from radium. It is well known that Kaufmann proved that the mass of such charged bodies increases measurably as the speed approaches that of light; and by comparison of his results with theory he deduced, by aid of a fairly plausible assumption, that the electrical portion of the mass was about a quarter of the whole.

His assumption, however, had been that the charged particles behave like conducting spheres, so that the lines of force would at high speeds re-distribute themselves on their surface in accordance with the calculations of G. F. C. Searle for metal spheres.

J. J. Thomson, however, prefers to regard electron or corpuscular particles as behaving like perfect points, only points the field of which is non-existent within a certain small sphere surrounding each, which therefore constitutes the charged surface. On this view, the distribution of the lines on the bounding surface of the flying particle would obey a different law from that of a conducting sphere at high speed, and the result of a re-calculation is to make electrical mass *equal* to the whole mass, to a remarkable degree of approximation. Thus, for instance, when the speed is $2{\cdot}85 \times 10^{10}$ centimetres per second, the observed mass is measured as 3·09 times

the mass of the same particle for slow speed; calculation makes it 3·1 times. When the speed is $2{\cdot}59 \times 10^{10}$, the observed mass ratio is 2·04; calculation makes it 2·0. When the speed is $2{\cdot}36 \times 10^{10}$, observation gives the ratio 1·65, calculation 1·5, which is not quite so good an agreement; but even this is nearer than anyone could have anticipated, while the other results are extraordinarily close. If Kaufmann's results stand the test of criticism and repetition, they constitute a verification of a fact which is of the utmost importance and of the highest theoretical interest, for it has the effect of reducing the whole Matter in the universe to Electricity, not as a speculation, but as an established truth. It would be rash to jump to such an important conclusion too hastily; and there remains a great outstanding difficulty, hardly yet even faced, concerning the nature of positive electricity—that vague and cometary termination of lines which at the other end are intensely concentrated.

Moreover, the view taken by J. J. Thomson of the nature of the lines of force—whereby their momentum when moving depends upon the mass of ether vortically included in each and inseparable from it—cannot be said exactly to *explain* "mass." Material mass is first explained electrically, and then electrical mass is relegated to the inertia of ether,—not the great bulk of ether, which may be as regards locomotion immovable, but the core of the columnar vortices associated with and essentially constituting the particles of which atoms of matter are composed. The massiveness of ether itself would thus be an unexplained fundamental fact, and its density would have to be regarded as extremely great. The probably high density of ether had already been surmised by FitzGerald and others, and although by this means the cosmos is reduced to a kind of glorified hydrodynamics, yet the fundamental properties of the continuous fluid itself remain unexplained and to all appearance inexplicable.

This may be regarded as a defect, but, after all, explanation always proceeds by stages, reducing the complex to the simple and introducing unification; it can hardly be considered likely that any theory accessible to us here and now can give anything approaching an *ultimate* explanation even of the simplest thing. If the present theory can be substantiated, with whatever modifications and enlargements may be found to be necessary, it will be an immense step in advance; but it would be premature to suppose that these views are in any sense final, or that they will be promptly and universally accepted. They have been led up to by the progress of science during the last quarter century, and a welcome has been gradually prepared for some of them, but the discrete and real physical nature of the lines of force radiating from an electric charge seems to me a novelty; although, as said before, a fibrous vortex structure for the ether had already been suggested and shown to be competent to transmit transverse vibrations. This essential requirement for any ether, the transmission of transverse vibration, necessarily involves some "structure" in the ether, as Lord Kelvin and others have all along perceived. Lord Kelvin favoured at one time a laminar structure, FitzGerald a fibrous structure, and Hicks had his own conception of a vortex sponge. But the difficulty in most cases was to show that these arrangements were stable and could persist without mutual destruction or hopeless wire-drawing. It is not clear whether this difficulty has or has not yet been attacked by J. J. Thomson in connection with the pictorial representation which he now brings forward.

He shows clearly, somewhat on the same lines as Mr. Heaviside, how sudden jerks or accelerations given to the lines must result in radiation, and he makes many interesting thumb-nail calculations in connection with their behaviour, among other things showing that the mass of bound or associated ether in an electrostatic line is such that if moving with the speed of light it would exactly equal the electrostatic energy of the field per unit volume; though how an electric field is to be thus thought of in any *static* manner is not clear to me. Also he is able to regard the re-distribution of the lines of a charge in rapid motion (first calculated by Mr. Heaviside in the *Phil. Mag.*, April, 1889) as not only analogous to, but as really corresponding to, the tendency of a moving cylinder to set itself broadways to the direction of motion. Furthermore, the lines of force behave very exactly as stretched elastic threads; for though their section is not uniform, their tension, *i.e.* their total stretching force, varies everywhere with their mass per unit length, so that the rate of propagation of waves along them is constant.

Altogether a fascinating and most readable book for students of physics and chemistry.

OLIVER LODGE.

SIR A. GEIKIE'S RECOLLECTIONS.

Scottish Reminiscences. By Sir Archibald Geikie. Pp. xii+447. (Glasgow: Maclehose and Sons, 1904.) Price 6s. net.

SCIENTIFIC readers will perhaps turn with most interest to the chapter in this charming book in which Sir Archibald, the last Scotchman for the time being who has directed the work of the Geological Survey of Great Britain, tells the story of the Scottish School of Geology. It is interesting to read along with it the pathetic lament of Principal Forbes, in Edinburgh, in 1862.

"It is a fact which admits of no doubt that the Scottish Geological School which once made Edinburgh famous, especially when the Vulcanist and Neptunian war raged simultaneously in the hall of this society"—the Royal Society of Edinburgh—"and in the class rooms of the University, may almost be said to have been transported bodily to Burlington House. Roderick Murchison, Charles Lyell, Leonard Horner, are Scottish names, and the bearers of them are Scottish in everything save residence—our younger men are drafted off as soon as their acquirements become known. Of all the changes which have befallen Scottish science during the last half century, that which I most deeply deplore, and at the same time wonder at, is the progressive decay of our once illustrious Geological School. Centralisation may account for it in part but not entirely."

But the nation, which did not greatly mourn when it sent its sixth King James to the sister country, did not, I think, suffer any more acutely when it saw its eminent sons, Sir Roderick Murchison, Sir Andrew Ramsay, and Sir Archibald Geikie, filling in uninterrupted succession the position of Director General of the Geological Survey of Great Britain. England may congratulate herself that she showed no narrow provincial jealousy, but chose the best men she could find in the island, to direct its geological survey, and their work and their fame are hardly less dear to their countrymen, because their later years were spent, as perhaps their best known work may have been done in the south. They owed their whole training and equipment to the Scottish School of Geology.

But the note of lamentation was a little too high pitched even for the days when Forbes struck it. It is true that the disputes of the Vulcanists and the Neptunists were rather forgotten with the names of Hutton and of Jamieson. In Forbes's time it had come to be recognised that both schools were substantially in the right—that volcanic forces on the one hand and water and ice on the other are forces almost equally potent in fashioning the earth as men knew it then and as they know it now, and Murchison, Lyell, Ramsay, Geikie brought people to recognise that each of the great elements took its own dominating part in sculpturing our hills and valleys, and in laying down and dislocating the strata of our rocks. In Scotland itself there were plenty of geologists to whose memories Sir Archibald Geikie pays loving and grateful tribute, who had never left their native Scotland. Two Edinburgh journalists, Charles Maclaren, who founded "The Scotsman," and Hugh Miller, who was "The Witness," spent a great part of their lives in the field of geology. Robert Chambers worked as hard on geological subjects as he did on the improvement of the literature and of the lives of his countrymen, and Principal Forbes himself, Mr. Peach, and Prof. James Geikie have not allowed the indigenous Scotchman to lose his claim to a great place among contemporary geologists.

Sir Archibald Geikie shows that his hand has lost none of its cunning, in the delightful word pictures he has given us of some of these famous and only half forgotten men of the early Victorian era. Here is a charming cameo:—

"The illustrious Principal Forbes himself was widely known to the geological world for his researches on the glaciers of the Alps and of Norway, and on earth temperature. As one saw him in the street or in the class room, he looked singularly fragile, and it was not easy to realise how such a seemingly frail body could have undergone the physical exertion required for his notable Alpine ascents. His tall, spare figure might be seen striding from the University to the rooms of the Royal Society, of which for many years he was the active secretary. His clear brown eyes wore a wistful expression and his pale face and sunken cheeks showed how his well-chiselled features had been preyed on by serious illness. Round his long neck he always wore one of the large neckcloths then in vogue, and above this, when out of doors, he carried a thick muffler, from under which as one passed him, one might hear now and then the cough that told of the malady from which he was suffering. In his own house, especially when showing some of the beautifully artistic water-colour drawings which he had made in the course of his wanderings, the then white, almost transparent, hands told the same tale of suffering."

Take another cameo, equally striking, of that wonderful stonemason and editor, Hugh Miller:—

"His appearance in the streets was certainly most uneditorial. Above the middle height, strongly built with broad shoulders, a shock of sandy hair, large bushy whiskers, and dressed in rough tweeds, with a shepherd's plaid across his shoulder, he might have been taken for one of the hill farmers, who on market days come to Edinburgh from the uplands of the Lothians He had the true 'Highland man's ling,' the elastic, springy and swift step of the mountaineer, accustomed to traverse shaking bog and rough moor. As he swung down the North Bridge, wielding a stout walking stick, looking straight before him, his eyes apparently fixed on vacancy, and his lips compressed, one could hardly help turning to look after him and to wonder what manner of man he could be."

Of the innumerable excellent stories which delight the readers of Sir Archibald's reminiscences I shall quote only two, and they shall be in connection with well-known scientific names. One tells us how "the late Professor Tait, so widely known, and so affectionately remembered, used to cite one of the answers he received in a class examination. The question asked was 'Define transparency, translucency, and opacity,' and the following was the answer, 'I am sorry that I cannot give the precise definition of these terms. But I think I understand their meaning, and I will illustrate it by an example. The windows of this class room were originally transparent, they are at present translucent, but if not soon cleaned they will become opaque.'"

Many old Edinburgh students will still "affectionately remember" these occasionally translucent windows, and will know how their never-to-be-forgotten professor would welcome the answer.

The only other quotation I shall permit myself is from a letter written by Ami Boué, a delightful old geological friend of Sir Archibald Geikie's younger days, who had been educated in Edinburgh, where he was caught up in his youth—about the time of Waterloo—in the maëlstrom of the great geological duello between the Vulcanists and the Neptunists. Boué wrote an "Esquisse Geologique sur l'Ecosse." which Sir Archibald describes as "a most valuable treatise, in many respects far in advance of his time." Born in Geneva, with German and Austrian connections, and educated in Scotland, he seems to have spoken most of the tongues of Europe with equal courage and inaccuracy. His Edinburgh days, however, were in 1870 far in the background of his life, but there are few Englishmen or Scotchmen who would have ventured to describe their feelings in a tongue with which they had been familiar in early life, as Ami Boué did, during the calamitous Franco-German war.

"The dreadful war pre-occupations did take me all time for thinking at scientific matter, and now perhaps that distress will approach till nearer our

abode! When you will know that I have very good and near parents in both armies, and you perceive the possibility of parents killing themselves without recognising themselves, nor having the opportunity to do so, you will understand that I have often headach when I ride the newspapers or hear from the quite useless slaughters which have been provocated only by those men at the head of the human society."

Too much language must have made his charming old geological friend a little mad, for Sir Archibald tells us that "all the letters to me, extending over a period of thirteen years," of this too cosmopolitan man of science, "were written in broken English," of which the letter above is a specimen.

The book is full of passages which recall one of the most delightful, and one of the earliest of Sir Archibald's books on the scenery of Scotland. I take a grateful farewell of the "Reminiscences" if you will allow me one more extract in illustration :—

"The fate of the Celt in the Highlands has been far different. There he has found himself in a region of mountains too rugged and lofty for cultivation, save along their bases, and too continuous to permit easy access from one district to another. . . . Shut in among long, narrow, and deep glens, he has cultivated their strips of alluvium, but has too often found the thin stony soil to yield but a poor return for his labour. For many a long century he had to defend his flocks and herds from the wolf, the fox and the wild cat. The gloom of his valleys is deepened by the canopy of cloud which for so large a portion of the year rests upon the mountain ridges and cuts off the light and heat of the sun. Hence his harvests are often thrown into the late autumn, and in many a season his thin and scanty crops rot on the ground, leaving him face to face with starvation and an inclement winter. Under these adverse conditions he could hardly fail to become more or less subdued and grim."

In passages like this, admirable in description and rich in human sympathy, the book abounds.

W. J.

THE NEW ZEALAND FAUNA.

Index Faunae Novae Zealandiae. Edited by F. W. Hutton. Pp. viii+372. (London: Dulau and Co., 1904.) Price 10s. 6d. net.

WITH the exception of the valuable introduction, by the editor, which appeals to a somewhat wider circle, this is essentially a book of reference, and as such is all-important to the scientific worker. In drawing up the list of the fauna, Captain Hutton has had the assistance of specialists in various branches of zoology who have undertaken the groups with which they are most familiar, so that the work may be regarded as thoroughly complete and up-to-date. Only two land mammals—bats are recognised as indigenous to the islands, the so-called Maori rat (*Mus exulans*) having apparently been introduced from Polynesia. This species, together with other wild forms introduced by human agency, are noticed in an appendix, and the reader will probably be surprised to find how large a list of foreigners has thus been added to the indigenous fauna. It should be mentioned that the text of the work is an "index" pure and simple, not even the local distribution of the various species being given.

After a brief historical survey of the acquisition of our present knowledge of the New Zealand fauna, Captain Hutton enters on a detailed discussion of the origin and relationships of that fauna, and since this is a subject to which he has for many years devoted special attention, his matured conclusions are of the highest value and importance.

The migratory portion of the fauna is very small, including only some half-dozen species of birds. The preponderating stationary portion may, according to Captain Hutton, be divided into a small aboriginal element, comprising species with no near relatives elsewhere, and larger Malay, Australian, and Antarctic elements, as well as several smaller ones. Among the aboriginal forms, that is to say, those which appear to have been inhabitants of the islands for a very long period, the author includes the short-tailed bat (Mystacops), the tuatera, and the kiwi. Taking a broad view of the fauna, it may be said that the terrestrial portion is mainly of Malay origin, but with somewhat strong Holarctic and Neogæic connections. This opinion is important in connection with the view that has been elsewhere expressed as to the Asiatic origin of the Australasian marsupials.

From the occurrence of a number of animals which it is impossible to believe could have crossed the sea, the author is of opinion that New Zealand is not entitled to be regarded as an oceanic island, but that at an epoch relatively remote it formed part of a large continent.

The land shells of the genus Endodonta, which range all through Polynesia, New Zealand, eastern Australia, New Guinea, and the Philippines, with an outlier in Ceylon, afford the best evidence in favour of a Polynesian continent, the Cingalese outlier pointing to the conclusion that this group of molluscs originally came from the north. The molluscan evidence will not, however, explain the South American connection.

The best zoological evidence of the latter connection, by way of Antarctica, is afforded by the earthworms of the family Acanthodrilidæ, which are unknown north of the equator, although their occurrence in Madagascar may point to a northern origin. The primary northern origin of the mainly fresh-water fishes of the genus Galaxias may perhaps also be indicated by the existence of the allied Cromeria in the Nile. Additional evidence of a connection with Patagonia is afforded by the occurrence in the Tertiary strata of South America and New Zealand of quite a number of shallow-water marine invertebrates, as, indeed, has been recently pointed out by Dr. von Ihering. Further, the occurrence of these forms in older strata in South America than in New Zealand points to the conclusion that the migration took place from the former to the latter area.

Lack of space alone prevents us from discussing in greater detail Captain Hutton's very interesting and suggestive views.

R. L.

OUR BOOK SHELF.

A History of the Daubeny Laboratory, Magdalen College, Oxford. By R. W. Günther, M.A., F.L.S. Pp. vi+137; 3 full page plates. (London: Henry Frowde, 1904.) Price 5*s.* net.

OXFORD chemistry is entering on a new phase of its existence. Up to the present time the theoretical teaching has been excellent, but partly owing to lack of accommodation and partly through other causes, the practical teaching has not reached so high a standard. Mr. Günther's book is a sort of commemoration of the opening of the reconstructed chemical laboratory at Magdalen College. The laboratory, apart from the Physic Garden, which is nearly four hundred years old, was founded in 1842, and it was the scene of Daubeny's labours both as chemist and botanist. His chemistry lectures were, however, given in a basement of the old Ashmolean building. It is to a certain extent typical of the earlier days of Oxford science that most of the work was relegated to cellars. Brodie's "last word on the formula of ozone" was said in a cellar at Balliol, and in the same cellar much of Dixon's excellent work on the rates of explosion in gases was done. Harcourt's classical experiments on velocity of chemical change were performed in a basement at Christ Church. Things are changing now. New laboratories have been built both at Christ Church and Magdalen, and in both, research laboratories, with the best appliances, give hope that chemical research in Oxford many be entering on a new lease of life.

Mr. Günther gives a very minute and interesting account of the laboratory now under his charge. Not the least interesting is his description of the collection of old apparatus which has been lying, fortunately unbroken, for many years in the laboratory. A complete meteorological record from 1869 has been kept, and the monthly averages are given in an appendix. A list of Daubeny's researches is also appended; the number of papers is very large, considering the fact that he was the holder of three several professorships—chemistry, botany, and rural economy. The researches of later workers in the laboratory are described in full. Mr. Günther has evidently been misled by the politeness of one of the learned societies. It is scarcely considered a mark of distinction for an author to have his paper "deposited in full in the Society's Archives."

The registers of attendance at the lectures of Daubeny are printed in full from 1826, with notes of the after careers of the students. It is a curious fact that fully three-quarters of the early attendants of science lectures in Oxford afterwards took Orders, and among them we find three archbishops, Tait, Whately and Thomson. In these later days science is apparently not so necessary for the education of the clergy.

Abriss der Biologie der Tiere. By Prof. H. Simroth. 2 vols. Pp. 157 each. (Leipzig: Göschen.)

THESE little books correspond to the series issued in this country by Messrs. Newnes, as the "Story of Fish-Life" and the like. But Dr. Simroth, possessing as he does a great knowledge of animal bionomics, has condensed within two small volumes all the essential facts of comparative physiology of animals in a way that is paralleled by no English work except Semper's "Animal Life." Unfortunately the Germans, with few exceptions, do not arrange and select their elementary science in a way that assists the beginner. Almost on the first page we meet with "idioplasma" and "chromosomes," a fact which is eloquent of the distance between writer and learner. Whilst this work is one of great value to teachers, it is well to understand that it is useless to those beginning the subject. The reviewer, however, as one who has known the stimulating character of Prof. Simroth's teaching, gladly acknowledges the suggestive and clear way in which the influence of gravity, light, heat, and other radiations are referred to. These, and the concluding chapters on reproduction, rudimentary organs, and habitat, are well worth the attention of those who have already acquired a practical knowledge of biology.

From India to Fergana. Description of a Journey made in 1898 by Lieut.-Colonel V. T. Novitskiy, being part of vol. xxxviii. of the *Memoirs* of the Russian Geographical Society. Pp. 297; with a map and 18 photographs. (St. Petersburg, 1903.)

STARTING from Srinagar, the author went first to Leh; thence, proceeding in a northern direction, he crossed the Karakoram Plateau, reaching the Karakash River, or Khotan-daria, at the Chinese post Shahi-dula. Then, instead of taking one of the usual passes across the Raskem Range, the Russian traveller went through a more western, formerly unknown pass, Karlik-davan, which proved to be extremely difficult, especially in the gorge of the Tagra-su. Descending next to the valley of the Ulyuch-su, the party soon reached Kargalyk, in Kashgaria, and Yarkand, and went to Russian Turkestan, following one of the usual routes. The author gives very good descriptions of Kashmir and of the dreary Karakoram Plateau, about 15,000 feet high in its high valleys, which are covered with alluvial deposits from old desiccated lakes, and are surrounded with bare mountains reaching an altitude of 24,600 feet in the Ak-tash group of peaks. He describes further the Alpine zone, intersected with wild gorges, which is usually known on the maps as the Raskem Range, but represents in reality an intermediate zone between the plateau and the plains of Kashgaria. He gives detailed lists of the plants he collected and of the birds he saw, and also most striking photographs, artistically reproduced. A map of the Pamirs and the surrounding regions, 27 miles to the inch, and a very interesting cross-section, based on the author's barometric measurements, are added to this valuable work.

Dissertations on Leading Philosophical Topics. By Alexander Bain. Pp. vi+277. (London: Longmans, Green and Co., 1903.) Price 7*s.* 6*d.* net.

THIS volume consists of fifteen essays on logical, psychological and ethical topics that have been previously published in the pages of *Mind* or elsewhere. Nevertheless a special interest attaches to it because the essays represent the maturest conclusions of the late Prof. Bain upon subjects to which he had devoted his attention with so conspicuous success throughout his long and distinguished career, and were designed by him to supplement the two great works on psychology which ill-health prevented him from again reissuing. The essays exhibit all that wide learning, that clearness and vigour of intellect, and that width of sympathy and interest which gave Bain's works on psychology a place in the foremost rank and secured for him a world-wide reputation. Very characteristic are the two essays in which he insists on the importance for psychology of physiological considerations and psycho-physical experiment, and at the same time defines their scope and their true relations to the introspective method. The volume concludes with an essay on the examination-system that assumes ever vaster proportions in this country in spite of many denunciations. Here Bain, recognising the necessity of examinations, appears as an advocate of improvement in the art of examining and of restriction rather than abolition of the system.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Relation between Uranium and Radium in some Minerals.

IN the course of an investigation which I am conducting on uranium-bearing minerals, the detailed results of which will be published shortly, I have come upon a point which seems to be of sufficient interest to warrant immediate publication. This is the close agreement between the amount of uranium and the amount of radium present in those minerals which have been examined.

The method which has been employed is briefly as follows:—A weighed quantity of the powdered mineral is introduced into a small glass bulb, which is connected with a larger bulb by a short tube. Attached to the bulb containing the mineral is another small bulb containing a small quantity of a suitable acid. The whole apparatus is sealed up at a slightly diminished pressure, and by tilting, the acid is brought into the bulb with the mineral, and the complete decomposition of the latter effected by gentle heating. At the end of a couple of days the larger bulb is sealed off from the smaller and allowed to stand for two hours to permit any rapidly decaying emanation which it may contain to dissipate. A small quantity of strong sodium hydroxide solution is introduced into the bulb, and the walls are thoroughly wetted in order to remove the acid fumes. The air contained in the bulb is then transferred to an air-tight electroscope and the rate of leak measured. In comparing the results obtained with different minerals the rate of leak at the end of three hours has been chosen, since at this time the rate of decay of the excited activity and its rate of formation are in equilibrium, and the readings of the electroscope are constant over considerable periods. The quantity of uranium in the solution is determined by analysis, and the ratio between the volumes of the two parts of the apparatus determined by measuring their separate capacities.

The results which have been obtained are as follows:—

No.	Substance	Per cent. Uranium	Grams Uranium taken	Leak divisions per min.	Ratio leak to Uranium
1	Uraninite	82·5	0·1067	22·5	211
2	Gummite	66·1	0·0982	20·8	212
3	Uranophane	46·6	0·0671	12·1	181
4	Uraninite	83·9	0·0994	20·6	207·2
5	Samarskite	9·5	0·0292	6·4	218

Nos. 1, 2, 3 and 5 from North Carolina; No. 4 from Branchville, Conn.

The slightly low value of the constant in No. 3 can be explained by the fact that this mineral at ordinary temperature gives off constantly a small proportion of its emanation, and is therefore not in complete equilibrium.

These results show a direct variation from those obtained by Mr. Strutt (*Proc.* Roy. Soc., lxxiii., 191), which may perhaps be explained by the fact that he secured the emanation by heating his minerals. Experiments which I have made show that on heating samarskite to low redness only 10 per cent. of the total emanation is given off, and that heating to bright redness releases only 20 per cent. of the total emanation obtained when the very finely powdered mineral is completely decomposed by heating with concentrated sulphuric acid. BERTRAM B. BOLTWOOD.

139 Orange Street, New Haven, Conn., U.S.A., May 7.

The Source of Radium.

As the subject of the origin of radium is being discussed, I may perhaps be permitted to make a suggestion.

The source of radium is at present being looked for on the assumption that it is the disintegration product of a substance of higher atomic weight. If this is so, we have apparently to choose between uranium and thorium. Mr. Soddy's experiment throws serious doubts upon the former being the source. The products of the latter appear to have been sufficiently far traced to render it doubtful that it can be the source. Again, the element thorium seems to be scarce in, or even absent from, some radio-active pitchblendes, if the older analyses are to be relied upon.

I would suggest that radium may not be derived purely as a disintegration product, but as an atomic combination of radio-active products with some of the elements present in pitchblende. Thus radium would represent the synthesis of an element, not its decomposition. On this view some of the radio-active products of uranium (or thorium) can, in virtue of their great kinetic energy, enter into the atoms of intermixed substances, such as barium, bismuth, &c., giving rise to the new atom radium. The new atom is, however, not very stable, and is consequently short lived. Hence its radio-activity.

If this hypothesis is correct, we should seek to observe the genesis of radium not in any one of the radio-active elements, but in molecular intermixtures of these with the various bodies we know to be conspicuously present in pitchblende, seeking among the various combinations for a positive result. The quantities of radium (or its emanation) to be expected as generated in a given time remain, of course, the same as on the hypothesis of disintegration; thus the experimental investigation presents no additional difficulties beyond its greater prolixity. J. JOLY.

Trinity College, Dublin, May 17.

As Mr. Soddy is absent from England, it may be permitted to me to comment on Prof. Joly's letter. The idea had occurred to us; but, as remarked, the experiments would be very "prolix."

A more promising field of research appears to be to try to ascertain whether the immense amount of energy evolved in various forms during the disintegration of the radium emanation may not be able to cause chemical change of a constructive nature; for example, to change bromine into iodine. An attempt has been made to see if this was the case, but without a positive result. That iodine would be the product of an addition of energy to bromine is of course a mere guess; but iodine is easily tested for, and hence the experiment. The difficulty will be in recognising with certainty the product of any such change, for the quantity of matter to be produced is, of course, extremely small. It is only, however, by such "mad" experiments that the capabilities of the radio-active bodies can be ultimately gauged. WILLIAM RAMSAY.

Radio-activity of Russian Muds and Electrification of Air by Metals.

THE researches of Elster and Geitel (*Phys. Zeitschr.*, v. p. 11) having led to the detection of radio-active power in the fine mud or "Fango" of the Italian watering-place Battaglia, induced me to undertake a study of the Russian muds in this character. Out of the five kinds of muds hitherto obtained by me and studied in a desiccated state, two muds, viz. that of the Odessa Kooyalnitzky Liman and that of Arensburg, on the Isle of Oesel, have proved undoubtedly to possess radio-activity, the first being radioactive in a higher degree than the second. In these researches we proceeded in a manner quite analogous to that of Messrs. McLennan and Burton in studying the electrical conductivity of the air (*Phil. Mag.*, v. p. 699, 1903). The present experiments were carried out with the most active participation of Mr. Athanassieff.

We employed two cylinders, a brass one 8·3 cm. in diameter and 20 cm. high, and another of zinc, 22·5 cm. in diameter and 35 cm. high. In each cylinder there was fixed along the axis a brass wire which was supported by an amber cylinder placed in a brass guard tube. The latter was connected with the earth, and embedded in an insulating ring put into an opening of the upper base of the cylinder. The wire of either cylinder could at will be connected with one pair of quadrants of a Dolezalek electrometer, the other pair being connected with the earth, and the leaf was charged to 100 V by means of a battery of storage cells. The wire, also of brass, connecting the cylinder wire with the electrometer, and the point of connection of that wire

with either cylinder wire, were surrounded by brass tubes connected with the earth. The sensitiveness of the electrometer was such as to produce for a ΔV of 0·01 V, a shifting of about 7 mm. on the scale. The connection of the cylinder wires with the earth was brought about by touching them with brass wires connected with the earth. In the whole there was not on the path from the cylinder wire to the electrometer any contact of two different metals. The cylinder was charged, as a rule, to 100 V by a battery of storage cells.

During the progress of these experiments a very interesting phenomenon presented itself. It was found that when either of the cylinders is connected with the earth, the wire enclosed within it, after being disconnected from the earth, immediately begins to get electrified, *i.e.* the electrometer thereupon indicates a rise of a potential, which continually increases during a certain interval of time, some hours in the main, before reaching a limiting value. (The electrification was observed when the mud was removed from the cylinders.) The wire contained in the zinc cylinder becomes positively electrified, whilst that in the brass cylinder becomes negatively electrified. Having remarked such a phenomenon, we introduced into the brass cylinder which opened from beneath, a zinc cylinder, placed coaxially so as to enclose the wire. This cylinder was in metallic connection with the surrounding brass one. In this case, too, the wire acquired a potential, but it was opposite in sign to that it acquired without such a zinc cylinder being merely enclosed in the brass cylinder, *i.e.* it became positively electrified. The maximum value of the potential produced in the wire amounted in our observations to 0·2 V. This maximum value depends, it seems, upon the degree of ionisation of the air in the cylinder.

We also replaced the zinc cylinder at the interior of the great brass cylinder by others of lead, aluminium, iron and silver, with the effect that the two former acted in the same direction as the zinc cylinder; the lead cylinder, which, by the bye, proved very radio-active, gave the strongest effect (about 0·35 V), whilst aluminium took the last place, zinc remaining in the middle. The iron and the silver cylinders, on the contrary, exerted the same action as the main brass cylinder, giving a negative electrification, but to a less degree.

The phenomenon we have observed seems to be in correspondence with effects produced in metals by air ionised with Röntgen rays (f. Borgmann and A. Gerchun, *C. R.*, cxxii. p. 378, 1896; Minchin, the *Electrician*, March 27, 1896; Rutherford, *Phil. Mag.*, xliii. p. 241, 1897). It may perhaps give the explanation of atmospheric electricity; and it is also of interest in the fact that here we take electrical energy directly from the air. I. BORGMANN.

Physical Institute, The University, St. Petersburg, May 9.

Graphic Methods in an Educational Course on Mechanics.

It is difficult to reconcile Mr. Milne's opening statement (NATURE, May 5, p. 5) with the rest of his letter. He begins by venturing to think that no one will gainsay Mr. W. Larden's main contention (NATURE, April 28, p. 607) that "analytical methods give a grasp of the principles of statics while graphical methods disguise them," and he goes on to give half a dozen instances confuting it. Mr. Larden wrote to elicit opinions from those who have taught mechanics, and as I have had only one pupil, a very troublesome one, namely, myself, I cannot think that my opinions are invited. But when Mr. Milne thinks that no one will gainsay the contention, the challenge is a wide one, and I deny it emphatically, and know that there are hundreds of men who will agree with me. These men are not teachers or mathematicians, but those who have to use mathematics for their profession or trade.

I have the highest admiration for all those to whom science is an end in itself. I fully appreciate the attitude of mind (the butt of so many jokes) which feels that mathematics and other sciences become degraded by useful applications. But for one true mathematician there are a thousand men to whom mathematics are but a means to an end. Many of these, like myself, are not mathematically minded (as Mr. Larden probably counts mathematics), and with the exception of Maxwell's "reciprocal figures" and a few others, we have had to work out graphical methods mainly for ourselves. Teachers are now coming round, or as Mr. Larden would put it, giving way, or as I would put it, waking up, and are recognising that analytical language, powerful as it is for research, is not paramount for explanation. "I believe," wrote Prof. J. Perry in his "Spinning Tops," "that there are very few mathematical explanations of phenomena which may not be given in quite ordinary language to people who have an ordinary amount of experience. In most cases the symbolical algebraic expression must be given first by somebody, and then comes the time for its translation into ordinary language."

I agree with the whole of Mr. Milne's letter except the first few words, and, like him, "I believe the best results will be obtained when the two methods are used side by side." Of my own acquaintances, about one in five prefer analytical methods, but the others have a diagram in their heads, if not before them on paper as a guide to bring it vividly before the mind (to borrow Mr. Larden's words). Mr. Larden concludes, "graphical work consumes an amount of time that seems out of proportion to the mental training and knowledge of principles gained." The title of his letter shows that he has "an educational course" in view, and *qua* education, "mental training and knowledge of principles" is the true and only object. His pupils should emerge as mathematicians. But those who have to use statics professionally would not hesitate to consume twice or thrice the time on a graphical method if it carries conviction of truth with it, as it does to two or three at least out of five of my acquaintances.

Mr. Larden dates his letter from Devonport, and this suggests that some of his pupils hope to become naval officers and not wranglers; that mathematics will be used by them in after life as a means to an end. Would he deny the use of a piece of string on a globe to explain "great circle sailing," or does he use a formula applicable generally to figures of revolution, of which the earth and Saturn's ring are particular cases? Sumner's method may be disguised in algebra, but it must be confessed that the famous "line" as discovered by him was a bit of pure graphics.

It may be impossible for Mr. Larden to appreciate the geometrical point of view, for my contentions are exactly the opposite of his first and fourth. For us non-mathematicians, "graphical methods give a grasp of the principles of statics, while analytical methods disguise them," and "analytical methods confuse learners of statics." The second contention, "Analytical methods must be mastered in any case," needs the addition of the words "by the help of diagrams." If there be any truth in the third contention, that "analytical methods connect statics with dynamics," it is of small importance if they fail to elucidate dynamics. Nature herself gainsays these contentions with the parabola of the fountain, the ripple of the pond, and the slope of the sand hill.

A. P. TROTTER.

8 Richmond Terrace, Whitehall, S.W., May 13.

ANY educational course in mechanics should undoubtedly be based first of all on experiment. If such is the case, it is practically impossible for any student using "graphical methods" to make the wild "shots" referred to by Mr. Larden (vol. lxix. p. 607), who seems to have been very unfortunate in the kind of boy he has received from "a preparatory school"; or is it the boy who has been unfortunate in his previous training? Has Mr. Larden considered the possibility of the "method of teaching" adopted being wrong in the aforesaid school? Surely there is no inherent quality in "graphical methods" to cause these wildest of "shots." The writer's experience goes entirely against this idea, and supports the contentions set forth by Mr. Milne.

Mr. Larden writes:—"If then, there be not time for both, it is the latter (Graphics) that should be sacrificed." If time is so short that some sacrifice must be made, the

writer is of opinion that it would be better to take a less comprehensive course than to omit "graphical methods" entirely.

The best method for mechanics, as for all physical sciences, is:—

(1) Experimental work to be carried out by the boys.

(2) Consideration of, discussion on, and deduction from the experimental data obtained by the boys, with an occasional demonstration by the teacher to clench any particular point. This treatment of the experimental work to involve both analytical and *graphical* methods.

In fact, a truly educational course in mechanics is impossible without experimental work. Granted this experimental work, the writer is of opinion that the aim of the students will be considerably improved, and not only so, but there will be a complete absence of wild "shots."

S. IRWIN CROOKES.

Secondary and Technical School Clay Cross, Chesterfield, May 15.

EUGENICS; ITS DEFINITION, SCOPE AND AIMS.[1]

EUGENICS is the science which deals with all influences that improve and develop the inborn qualities of a race. But what is meant by improvement? We must leave morals as far as possible out of the discussion on account of the almost hopeless difficulties they raise as to whether a character as a whole is good or bad. The essentials of eugenics may, however, be easily defined. All would agree that it was better to be healthy than sick, vigorous than weak, well fitted than ill fitted for their part in life. In short, that it was better to be good rather than bad specimens of their kind, whatever that kind might be. There are a vast number of conflicting ideals, of alternative characters, of incompatible civilisations, which are wanted to give fulness and interest to life. The aim of eugenics is to represent each class or sect by its best specimens, causing them to contribute *more* than their proportion to the next generation; that done, to leave them to work out their common civilisation in their own way.

The course of procedure that lies within the functions of a learned and active society would be somewhat as follows:—

(1) Dissemination of a knowledge of the laws of heredity so far as they are surely known, and promotion of their further study. Few seem to be aware how greatly the knowledge of what may be termed the *actuarial* side of heredity has advanced in recent years. The *average* closeness of kinship in each degree now admits of exact definition and of being treated mathematically, like birth- and death-rates, and the other topics with which actuaries are concerned.

(2) Historical inquiry into the rates with which the various classes of society (classified according to civic usefulness) have contributed to the population at various times, in ancient and modern nations. There is strong reason for believing that national rise and decline are closely connected with this influence.

(3) Systematic collection of facts showing the circumstances in which large and thriving families have most frequently originated; in other words, the *conditions* of eugenics, on which much more information is wanted than is now to be had. It would be no great burden to a society, including many members who had eugenics at heart, to initiate and to preserve a large collection of such records for the use of statistical students. The committee charged with the task would have to consider very carefully the form of their circular and the persons entrusted to distribute it. They should ask only for as much useful information as could be easily, and would be readily, supplied by any member of the family appealed to. The point to be ascertained is the *status* of the two parents at the time of their marriage, whence its more or less eugenic character might have been predicted if the larger knowledge that we hope to obtain had then existed. The reasons would have to be shown why the children deserved to be entitled a "thriving" family. A manuscript collection such as this might hereafter develop into a "golden book" of thriving families. The act of systematically collecting records of thriving families would have the further advantage of familiarising the public with the fact that eugenics had at length become a subject of serious scientific study by an energetic society.

(4) Influences affecting marriage. The remarks of Lord Bacon in his essay on death may appropriately be quoted here. He says, with the view of minimising its terrors:—

"There is no passion in the mind of men so weak, but it mates and masters the fear of death. . . . Revenge triumphs over death; love slights it; honour aspireth to it; grief flyeth to it; fear pre-occupateth it."

Exactly the same kind of considerations apply to marriage. The passion of love seems so overpowering that it may be thought folly to try to direct its course. But plain facts do not confirm this view. Social influences of all kinds have immense power in the end, and they are very various. If unsuitable marriages from the eugenic point of view were banned socially, or even regarded with the unreasonable disfavour which some attach to cousin-marriages, very few would be made. The multitude of marriage restrictions that have proved prohibitive among uncivilised people would require a volume to describe.

(5) Persistence in setting forth the national importance of eugenics.

There are three stages to be passed through before eugenics can be widely practised. First, it must be made familiar as an academic question, until its exact importance has been understood and accepted as a fact. Secondly, it must be recognised as a subject the practical development of which is in near prospect, and requires serious consideration. Thirdly, it must be introduced into the national conscience, like a new religion. It has, indeed, strong claims to become an orthodox religious tenet of the future, for eugenics cooperate with the workings of nature by securing that humanity shall be represented by the fittest races. What nature does blindly, slowly and ruthlessly, man may do providently, quickly and kindly. As it lies within his power, so it becomes his duty to work in that direction, just as it is his duty to be charitable to those in misfortune. The improvement of our stock seems one of the highest objects that can be reasonably attempted. We are ignorant of the ultimate destinies of humanity, but feel perfectly sure that it is as noble a work to raise its level as it would be disgraceful to abase it. I see no impossibility in eugenics becoming a religious dogma among mankind, but its details must first be worked out sedulously in the study. Over-zeal leading to hasty action would do harm by holding out expectations of a near golden age which would certainly be falsified and cause the science to be discredited. The first and main point is to secure the general intellectual acceptance of eugenics as a hopeful and most important study. Then let its principles work into the heart of the nation, which will gradually give practical effect to them in ways that we may not wholly foresee.

[1] Abridged from a note read before the Sociological Society on May 16 by Dr. Francis Galton, F.R.S.

SOME GERMAN PUBLIC LABORATORIES.

In considering the success of German manufactures we are doubtless justified in regarding education as the ultimate cause. But proximate causes are also worth noting, and among these is the facility of access to the fountain-head of science enjoyed by German manufacturers. In England, as elsewhere, a manufacturer hesitates to take scientific experts into his employ unless his industry be on rather a large scale, but in Germany, at any rate, he has for some time been able to acquire the very best of scientific aid, as it were, retail. This fact is brought home by a study of some of the German industrial testing stations recently published by M. A. Granger in the *Bulletin de la Société d'Encouragement.*

The first of these institutions on M. Granger's list is also the most interesting, since it is not a State creation, but rests, in essence, on the historically English basis of cooperation. The laboratory of the Tonindustrie Zeitung in Berlin, together with the journal from which it takes its name, thrives upon the support of nine associations of manufacturers turning out pottery, cement, builders' materials, &c. It is housed in an admirably planned building of three stories, of which the uppermost is set apart for the business of the Zeitung. The laboratories are designed for the study of such goods as bricks and tiles, terra-cotta, fireclay, earthenware, porcelain, and cement, and their primaries. The clays serving as raw materials are subjected to elutriation, to determinations of plasticity, porosity, and fusibility, and to chemical analysis. In another department they are experimentally baked; here also Seger's cones are made and furnace gases analysed. The testing of cements includes rate of hardening, variation of volume, resistance to hammering, and tensile strength. Manufactured articles, finally, undergo tests for mechanical strength and for resistance to abrasion.

The laboratory is entirely at the service of manufacturers not only for tests, but also for investigations, including geological prospecting. To round off its completeness, it carries on a patent agency and an instrument business. Altogether some fifty persons are employed.

Better known to the world at large is the Kgl. Mechanisch-Technische Versuchs-Anstalt of Charlottenburg, now removing to the remoter suburb of Gross-Lichterfelde. Founded by ordinances of the Prussian Government in 1880 and 1882, it performs investigations and tests for the various Government departments (including railways) and for private clients. There are four departments, with a supreme director. The metals department is equipped for all the usual engineers' tests and for photographic metallography; its chief glories are a 500 ton horizontal testing machine by Hoppe, and a machine for crushing tests, of which the monkey weighs 600 kg. and falls through 10 metres. The other departments are concerned with builders' materials, papers and textiles, and lubricants respectively. The paper testing of the Versuchs-Anstalt is, perhaps, the best of its kind; its methods have been rendered familiar by the book of Dr. Hertzberg, the head of the department.

M. Granger further mentions the Kgl. Chemisch-Technische V.-A. in central Berlin, which is also kept up by the Prussian Government. It appears to be practically a commercial analyst's laboratory on the large scale. The well known Physikalisch-Technische Reichsanstalt of Charlottenburg owes its maintenance not to Prussia, but to the Empire.

In this, as in other respects, Bavaria declines to stand by whilst Prussia makes the running. Since 1891, we learn, there have been a Material-Prüfungs-Anstalt and a Chem.-Techn. V.-A. in Nuremberg, both State institutions; though on a comparatively small scale, they are in a flourishing way, and are business-like enough to charge lower fees than their Prussian analogues.

W. A. C.

DR. G. J. ALLMAN, F.R.S.

George Johnston Allman was born in Dublin in the year 1824, the son of Dr. William Allman, who was professor of botany in the University of Dublin from 1809 until 1844. He entered Trinity College at an early age, and at the honour degree examination he obtained senior moderatorship and a gold medal in mathematics in the year 1843. He was thus a contemporary of Samuel Haughton, who was first senior moderator in Dr. Allman's year, and of Sir Thomas Moffett, with whom he was so long associated in Galway. Early in the 'fifties Dr. Allman was elected to the professorship of mathematics in Queen's College, Galway, one of the colleges affiliated to the then recently constituted Queen's University in Ireland, and at Galway he remained until the close of his long life. Soon after the foundation of the Royal University in place of the Queen's University, Dr. Allman was nominated one of the senators by the Crown—a signal testimony to the high reputation he had made among his friends and colleagues in the Queen's University. He held his professorship for nearly forty years, when he was obliged to retire in accordance with the Civil Service regulations respecting the age limit.

Dr. Allman's most remarkable mathematical works relate to the paraboloids (on some properties of the paraboloids, *Quarterly Journal of Mathematics*, 1874) and to the history of Greek mathematics. During the years 1877–87 he published a series of papers in Hermathena which formed the basis of his celebrated work, "Greek Geometry from Thales to Euclid" (Dublin University Press Series). He also wrote the articles in the ninth edition of the "Encyclopædia Britannica" on Ptolemy, Pythagoras and Thales. In 1884 he was elected a Fellow of the Royal Society.

Like his class-fellow, Dr. Haughton, Allman was much interested in natural history, especially in the collection and study of sea-shells. He was fond of chess, and though perhaps he would hardly have called himself a mountaineer, he thoroughly enjoyed a ramble in some mountainous district and had full experience of the fascination the mountains have exerted over so many men of science.

NOTES.

The delegates attending the assembly of the International Association of Academies were entertained by the Royal Society at a banquet at the Hôtel Métropole on Tuesday. Sir William Huggins, president of the society, occupied the chair. Lord Goschen, in proposing the toast of the evening, "The International Association of Academies," said that a hundred years ago the metaphysical interests seemed to predominate over the interests of physical science, but the conditions were now entirely reversed, and it seemed as if physical science were going to rule the world. Nations seemed to look to physical sciences as if on them their prosperity depended, and the nation which paid the greatest homage to physical sciences would be the nation which would win among the nations of the universe. But might he put in a plea at the same time for the moral and metaphysical and the political sciences? He was glad to think that in most of the academies there was a section of the moral and political sciences side by side with the physical

sciences, but they could not achieve the same striking results. He thought it highly desirable that side by side with physical sciences the societies which devoted themselves to moral and political sciences should be able to hold their own, and he appealed to the representatives of those academies to try to vie in energy and in determination to succeed with those who represented physical science alone. Replying to the toast, the Comte de Franqueville remarked that science belonged to no country, and was essentially the patriotism of humanity. Every scientific discovery, every conviction, every step of progress, whoever the author might be, in whatever country it took place, was spreading to every land like the beams of the sun illuminating the worlds. It was natural that all should contribute to that which should be a profit to all; to individual efforts and labours they gave a common impetus, in grouping and classifying the numerous problems which humanity had not yet solved.

Sir William Huggins, K.C.B., has been elected a foreign associate of the U.S. National Academy of Sciences; and also an honorary member of the Royal Philosophical Society of Glasgow.

The *Times* correspondent at Colombo announces that Dr. Castellani has discovered the bacillus of dysentery, and will shortly read a paper upon the subject before the Medical Association.

The *Globe* reports that Dr. Gottfried Merzbacher, who has been engaged for two years on a scientific expedition in the Thian-shan Mountains, in Central Asia, has returned to Munich with many objects of geological, palæontological, zoological and botanical interest.

A Reuter telegram from Malta states that a slight shock of earthquake was felt there at 6.13 a.m. on May 21.

A Reuter message from Copenhagen, dated May 21, states that the Danish scientific expedition to Greenland has arrived in the Danish colony of West Greenland, and reports that the Gjoea expedition, which started in August of last year, was found at Dalrymple Rock. All the members of both expeditions are well.

We learn from the *British Medical Journal* that the International Congress of Physiologists will hold its sixth meeting at Brussels this year from August 30 to September 3. All communications relative to the congress should be addressed to Dr. Slosse, Institut Solvay, Parc Leopold, Brussels, before July 1.

The annual meeting and conversazione of the Selborne Society will be held at the Civil Service Commission, Burlington Gardens, to-morrow, May 27. Lord Avebury, the president of the society, will give an address. There will also be a lecture, by Prof. B. H. Bentley, on "Flowers and their Insect Visitors," and one by Mr. Fred Enoch on "Colour Photography of Living Insects."

We have received from the secretary of the Library Association a report of the proceedings of the committee of the Library Association on binding leathers. We notice that more than sixty institutions have undertaken to try the new leathers prepared—in accordance with the recommendations of the committee appointed by the Society of Arts—to obviate the rapid deterioration of book-binding leathers. It is hoped that British producers will take care to prepare the light leathers specified.

At a sale recently held by Mr. Stevens in King Street, Covent Garden, a great auk's egg in fine condition was sold for two hundred guineas, the purchaser being Mr. Pax. This is a considerable falling-off from the three hundred guineas obtained for the last specimen sold by Mr. Stevens, the reason being attributed to the fact that several other fine examples are in the market. Mr. Pax's specimen was originally bought for two sovereigns. The next highest price obtained at the recent sale was *8l.* 18*s.* 6*d.* for a clutch of four eggs of Bonaparte's sandpiper. For a single egg, the highest price was 27*s.* 6*d.* for one of Pallas's sand-grouse.

Mr. A. W. McCurdy, at a recent meeting of the Canadian Institute, gave an account of his invention of the device for developing photographs without a dark room, now so well known as the Kodak developing machine. It appears that his first idea was to use one solution that would both develop and fix, containing pyrocatechin as the developer. He afterwards employed a combined developer and fixer containing pyrogallol and sodium carbonate to avoid the troublesome caustic alkali. But separate developing and fixing solutions have always been recommended by the commercial makers of the apparatus, doubtless because of the greater certainty when the operations are individually controlled.

The death is announced of Mr. J. N. Tata, the millionaire philanthropist of Bombay. A correspondent of the *Times* points out that Mr. Tata made experiments extending over a series of years for the acclimatisation of Egyptian cotton in India, and in suitable localities these met with some measure of success. In many other directions, notably that of sericulture after the Japanese method in Mysore, the extension of the use of artesian wells and the introduction of cold storage, Mr. Tata contributed to the industrial expansion of the country of his birth. Mr. Tata, by means of his scholarships, tenable by Indian youths of special promise in this country as well as on the Continent and in America, afforded many of his young fellow-countrymen exceptional opportunities for gaining technical knowledge. The Indian University of Research, to be created at Bangalore as the outcome of his offer of an endowment of 200,000*l.*, will be the monument of his beneficent career.

In the death of Mr. Frank Rutley, geological science has lost an enthusiastic worker on rocks and rock-forming minerals—one of the earlier investigators who brought the microscope to bear on petrological studies. His interest in geology was kindled at the Royal School of Mines, but he served as lieutenant in the army for a few years before 1867, when he joined the staff of the Geological Survey under Murchison. After carrying on field work for a time in the Lake District, he began to devote his special attention to the study of igneous rocks, and was transferred to the office in Jermyn Street, where he laboured for a number of years as acting petrologist. In 1876 he described the volcanic rocks of east Somerset and the Bristol district, and subsequently wrote memoirs on the eruptive rocks of Brent Tor and on the felsitic lavas of England and Wales. He was the author of the first English text-book of petrology, "The Study of Rocks" (1879), also of "Rock-forming Minerals" (1888) and "Granites and Greenstones" (1894). He likewise published a very useful handy book of mineralogy which passed through several editions. To the Geological Society he communicated papers relating to perlitic and spherulitic structures, fulgurites, novaculites, &c., and a special memoir on the rocks of the Malvern Hills. In 1881 the Murchison fund was awarded to him by the council of the society. He resigned his post on the Geological Survey in 1882, when he was appointed lecturer on

mineralogy in the Royal School of Mines (afterwards merged in the Royal College of Science). A few years ago he was stricken down with paralysis, and was forced to retire from the public service; but he laboured on as far as his strength permitted with wonderful patience and interest, animated by a cheery nature, and he was able to accomplish much useful work until within about two years of his decease.

WE are glad to find that the study of the meteorological conditions of the Transvaal and Orange River Colony has been taken up seriously by the respective Governments. With regard to the service in the Transvaal, we find some interesting particulars given in *Symons's Meteorological Magazine* for May. The director of the service is Mr. R. T. A. Innes, and the central observatory, which is three miles north-east of Johannesburg, stands at a height of about 5900 feet above sea-level. The grounds cover $10\frac{1}{2}$ acres, and were obtained partly by purchase and partly by gift of a Dutch family named Bezuidenhout. There are already 200 rainfall stations in operation, in addition to about 30 stations of the second and third orders. All the rainfall observers have come forward voluntarily, many of them being farmers and school teachers in thinly populated districts. A weather report is already issued daily, based on observations received by telegraph, and self-recording instruments are on the way to South Africa, and will probably be in working order by the beginning of July.

MESSRS. D. SCHULTE AND CO. have submitted a sample of their self-lighting Bunsen burner, in which the well known property of finely divided platinum igniting under the influence of a stream of hydrogen is employed. The burner proper is of the usual type, but is furnished with a byepass tube at the side, controlled by a cross stopcock. At the top of the byepass, close to the open end of the burner, there is fitted a small bracket holding the bundle of several fine platinum filaments, so constructed that the thin stream of gas from the byepass tube impinges on the stretched wires. A movable metal hood fits over the lighter to direct the pilot flame produced by the action of the platinum to the Bunsen tube, and on turning the stopcock to give full supply, the burner is lighted. The arrangement works very readily, and if the old difficulties with regard to the durability of the delicate portions can be surmounted, the apparatus should be of considerable convenience to laboratory workers.

IN the *Bulletin* of the Johns Hopkins Hospital for March (vol. xv., No. 156), Dr. Eugene Opie writes on the relation of leucocytes with eosinophile granulation to bacterial infection, finding that they are attracted from the blood to the site of the bacterial invasion. Dr. Thomas McCrae gives an interesting biographical notice of George Cheyne, an old London and Bath physician of the seventeenth century. The other papers are of purely medical interest.

THE report of the Inter-Departmental Committee on the Model Course of Physical Exercises has recently been published. The committee was instructed "to examine the model course now in use, to judge how far it should be modified or supplemented, and to consider what principles should be followed, in order to render a model course, or courses, adaptable for the different ages and sexes of the children in public elementary schools." The conclusion arrived at is that the "model course" as at present in use is not completely satisfactory. An elaborate scheme of exercises, no less than 109 in number, has therefore been drafted, and should prove of considerable service to teachers and others.

TWO papers on invertebrates have just been received. In the first Miss H. Richardson (*Proceedings* U.S. Nat. Mus., No. 1369) describes numerous new types of isopod crustaceans collected in Alaska and Hawaii. In the second, which is extracted from the *Mark Anniversary Volume*, Mr. J. H. Gerould discusses certain features in the embryology of the sipunculid annelids, dealing more especially with the structure and homology of the peculiar embryonal envelope and its amniotic cavities.

THE Leishman-Donovan body or parasite has been the subject of a research by Lieut. Christophers (*Sc. Mem. of the Gov. of India*, No. 8). It is met with in India in patients suffering from chronic fever, cachexia, and enlarged spleen. It occurs as a small round or ovoid body 1·5 to 3·5μ in diameter, free or contained within the leucocytes in the liver and spleen and bone-marrow, but not in the muscles or in the peripheral blood. Christophers observed the parasites also in the arachnoid and in ulcers of the large intestine. He agrees with other British observers that the organism is not a *piroplasma*, as stated by Laveran.

IN the April number of the *Journal* of the Quekett Microscopical Club (ix., No. 54), Mr. Julius Rheinberg directs attention to a point concerning the resolving power of a microscopical objective that has been overlooked. As is well known, the numerical aperture of an objective must be of a certain degree in order to resolve a number of equidistant points or lines, and it has been tacitly assumed that the same numerical aperture is required whether the number of lines be two, four, six, or a large number. If, however, there be only two lines, it will be found that they can be resolved with a numerical aperture sensibly less than that required to resolve a large number. The mathematical explanation has been given by Dr. Johnstone Stoney and by Lord Rayleigh.

TWO *Bulletins* have been received from the Experiment Station of the Colorado Agricultural College. In the first Mr. Paddock deals with "crown gall," the name applied to irregular outgrowths which are formed just below the ground at the base of trees, principally fruit trees. It has been referred to the irritation set up by a slime-fungus, and Prof. Toumey has succeeded in developing galls by inoculation. The pamphlet by Mr. Blinn directs attention to the importance of careful selection of seed as illustrated in the case of the Canteloupe.

THE movements of the stomata of leaves is a subject of which Mr. F. Darwin, F.R.S., has made a special study, and the latest paper published in the *Botanical Gazette* furnishes an account of observations made with a Callendar recorder, which is a form of resistance thermometer. Platinum wires are arranged in a zig-zag on plates of talc, and two of these act as "bulbs" against which the leaves are pressed. In general, a withered leaf is used as a control. The results agree with those obtained with the horn hygroscope, and, to quote one instance, the curve produced by severing a leaf shows very clearly the preliminary opening followed by a gradual closing of the stomata.

"INSECTS Injurious to Fruits in Michigan" is the title of an illustrated *Bulletin* issued by the Agricultural College of that State.

IN the course of a paper on metabolism and division in the Protozoa, published in the *Proceedings* of the American Academy, Mr. A. W. Peters points out the important in-

fluence exercised by the particular salt contained in the water on the growth and normal action of free-living cells; cell division in the animalcule Stentor being both accelerated and modified in character by an excess of potassium chloride in a normal medium.

THE London County Council is to be congratulated on the issue, at the price of one penny, of a handbook to the collection in the Horniman Museum at Forest Hill, arranged as an introduction to the study of animal life. Although some of the words and sentences are perhaps a little too technical for the class who will use it, the book forms an admirable guide to the general principles of zoology, and is an honest attempt to put them in a popular guise.

WE have received the prospectus of what promises to be a very useful and interesting work, "The Animals of New Zealand," by Messrs. Hutton and Drummond. As it deals only with the air-breathing vertebrates of the colony and its coasts, the bulk of its contents will be devoted to birds. Another faunistic work on our table is the second part of the Boston Society's "Fauna of New England," containing the Batrachia, drawn up by Mr. S. Henshaw.

THE contents of the February number of the *American Naturalist* are restricted to four articles, of which three are devoted to the lower vertebrates. In the first, Prof. H. F. Osborn emphasises in popular language his views with regard to the classification of reptiles, in the course of which he urges the propriety of forming families on phylogenetic lines. He would, for instance, include the Eocene Hyracotherium in the horse family (Equidæ), while a closely allied contemporaneous genus is included among the tapirs. The early stages in the development of an American salamander (*Desmognathus fuscus*) form the subject of a communication by Prof. Wilder, while Miss Townsend discusses the histology of the light-organs of the fire-fly *Photinus marginellus*. Apparently the author accepts the view that the latter organs are modified fat-bodies. Finally, Mr. E. G. Mitchell points out the relation of the breathing valves in the mouths of bony fishes to the shape of the mouth itself.

A USEFUL summary of the metalliferous mining in Ireland has been contributed by Mr. G. H. Kinahan to the *Transactions* of the Institution of Mining Engineers.

WE have received the annual report of Mr. H. B. Kümmel, State Geologist of New Jersey. It includes accounts of floods, forest fires, and underground waters, and reports on iron, zinc and copper mining, and on the Portland cement industry.

WE have received the *Transactions* of the Geological Society of South Africa, vol. vi., parts i. to vi., a well illustrated and clearly printed volume, dealing, as might be expected, largely with the metalliferous and coal deposits, and also with petrological questions. Mr. J. P. Johnson contributes a paper on the discovery of implement-bearing deposits in the neighbourhood of Johannesburg. In high-level drift near Roodekop Farm he has found water-worn implements of quartzite of Eolithic type, much resembling those of the plateau gravel of the Thames basin. At lower levels, along the bottom of the Bezuidenhout valley, he obtained implements of Palæolithic type, the deposits being evidently of later date than the high-level drift. Elsewhere he has found implements of Neolithic type. In his opinion the facts indicate that "South Africa saw much the same evolution in the culture of its Stone age as did that of the Thames basin and the rest of Britain and Western Europe." The fossil flora of Vereeniging is treated of by Mr. T. N. Leslie, who, aided by the researches of Mr. A. C. Seward, gives revised lists of the plant remains from the Permo-Carboniferous strata.

THE Permian fossils of the central Himalayas are described by Dr. Carl Diener (*Mem.* Geol. Survey India, series xv., vol. i., part v., 1903). In previous parts of this volume, Nos. 2 to 4, the fossils obtained by the Geological Survey up to the year 1893 from the "Anthracolithic series" (Permian portion) were described. In the present work Dr. Diener deals with specimens collected during the years 1898–1900. Under this method the fossils are treated according to their stratigraphical horizon and locality. The localities include Chitichun, Malla Sangcha, the Lissar Valley, Byans, and Spiti. In Spiti the Anthracolithic system is divided into two groups separated by a great unconformity—the upper group is regarded as Permian, and the lower as of Upper Carboniferous age. In the Permian system, to which attention is now directed, two facies are recognised in the Himalayas, and these differ in lithological and faunistic characters. One facies is represented by the white and red limestones of Chitichun and Malla Sangcha, and it corresponds with the topmost zone of the middle Productus limestone of the Salt Range and with the Tibetan series. In the other facies, developed in the main region of the Central Himalayas, the Permian strata comprise dark shales and calcareous sandstones; the fauna is composed of cephalopods, lamellibranchs, gasteropods and brachiopods, while corals and Bryozoa are wanting, and the majority of the leading fossils are autochthonous species, none of which has been found outside the Himalayas. Only a small percentage of species is identical with Salt Range forms, and the affinities with the Tibetan facies are less distinctly marked.

THE account of the genus Diospyros, contributed by Mr. H. Wright to the *Annals* of the Royal Botanic Gardens, Peradeniya, constitutes a monograph of the Ceylon species. *Diospyros Ebenum*, which is the main source of ebony-wood in Ceylon, is found both in the dry and wet regions of the island, and is considered to be ready for felling when the tree has attained a breast-height circumference of 9 feet. The different species vary considerably in the colour of their heart-wood; in *D. Ebenum* the black heart-wood owes its colour mainly to chemical and physical changes of the materials stored in the elements of the wood, and to a less degree to a change in composition and colour of the cell walls. Considerable variation occurs also in the types of flowers, and in *D. Ebenum* the flowers may be diœcious, monœcious, or polygamous.

IN the *Proceedings* of the Royal Dublin Society, Dr. T. Johnson describes a fungal disease which was found upon the willows known as "black mauls" growing in osier beds in Connemara, and identifies the fungus as *Physalospora gregarina*, a member of the Sphæriaceæ. The willows were growing on poor and sour land, and owing to their impoverished condition were especially liable to the attacks of the fungus.

THE development of scientific investigation and methods in connection with the agriculture of the West Indies has been a prominent feature in the policy of Sir D. Morris, the Commissioner of Agriculture, and an instance of the valuable work which is being carried on is furnished by the reports on sugar cane experiments which have been conducted at Antigua and St. Kitts under the super-

intendence of Mr. F. Watts. The first part deals with the cultivation of selected varieties of canes grown in the same way as the ordinary crops on the estate. The Barbados seedling B. 208 again heads the list, both in the matter of providing the heaviest canes and producing the purest juice; at the same time it retains its excellent character as a ratoon cane. Another set of experiments, continuing the work of former years, deals with the question of manuring. The evidence is opposed to the value of artificial manures for plant canes when the land has been well prepared with pen manure, but for obtaining maximum crops with ratoons the addition of nitrogenous salts is necessary.

THE first part of vol. i. of the new series of the *Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne* has now been issued. Among other interesting contents may be noticed "Notes on Entomostraca Found at the Roots of Laminariæ," by Dr. G. S. Brady, F.R.S., and papers by Mr. Clephan on ancient Egypt, and by Mr. Alex. Meek on the fishes of the north-east coast.

THE seventieth annual report of the Bootham School (York) Natural History, Literary, and Polytechnic Society, a copy of which has been received, affords abundant evidence of the importance attached by the masters of this school to the development in boys of an interest in practical work in science and in open-air study of natural phenomena. The report should be seen by science masters in secondary schools where little is done to create and foster interest in personal observations of nature.

THE British Fire Prevention Committee has issued, as number eighty-one in its series of publications, a descriptive paper by Mr. Edwin O. Sachs on the fire at the Iroquois Theatre, Chicago, on December 30, 1903. The publication also contains the new theatre regulations at Chicago, and notes on constructional particulars by the U.S.A. National Fire Protection Association. It appears that the stage of the Iroquois Theatre was of the ordinary type with the usual wood equipment. The stage accessories, scenery, properties, &c., were of the ordinary highly inflammable character, and had been in use for a considerable time, which involved the usual fraying and high grade of inflammability. The electric arc lamps used on the stage were not properly enclosed or suitably protected, and the fire appliances and exits were equally unsatisfactory. Mr. Sachs, after reviewing the whole circumstances of the fire, gives a number of general conclusions which deserve attention. He insists that fire prevention on the stage—where the Iroquois fire originated—can only be obtained by suitable incombustible construction and equipment. The scenery, properties, and furnishings of the stage must be thoroughly impregnated, so that they do not catch or spread fire by any spark or flame. When it is remembered that this Chicago fire resulted in 572 deaths, it is not too much to demand that city authorities should make the best use of the means provided by science to prevent such outbreaks of fire.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE:—

June 1. 12h. Jupiter in perihelion.
5. Ceres in opposition to the Sun. Ceres mag. 7·4.
,, 14h. 13m. to 16h. 30m. Transit of Jupiter's Sat. III. (Ganymede).
8. 8h. Mercury at greatest elongation, 23° 46′ W.
9. 12h. 34m. Minimum of Algol (β Persei).
12. 9h. 23m. ,, ,, ,,
15. Venus. Illuminated portion of disc = 0·994, of Mars = 0·999.
18. Saturn. Major axis of ring = 41″·62. Minor axis = 9″·73.
19. 5h. Uranus in opposition to the Sun.
24. 11h. 55m. to 12h. 30m. Moon occults θ Libræ (mag. 4·3).
29. 17h. Venus in conjunction with Neptune, ♀ 1° 24′ N.

COMET 1904 *a*.—In No. 3947 of the *Astronomische Nachrichten*, Prof. Strömgren publishes a new set of parabolic elements, and a daily ephemeris extending from May 18 to June 19, for comet 1904 *a*. The following is taken from his ephemeris:—

12*h*. (*M.T. Berlin*).

1904		α h. m. s.	δ ° ′	log *r*	log Δ	Brightness
May 26	...	14 17 17	+58 9	0·4534	0·4033	0·72
,, 30	...	14 0 55	+58 4	0·4554	0·4136	0·68
June 3	...	13 45 51	+57 48	0·4576	0·4241	0·64
,, 7	...	13 32 15	+57 22	0·4598	0·4349	0·61
,, 11	...	13 20 8	+56 49	0·4621	0·4457	0·57
,, 15	...	13 9 27	+56 11	0·4644	0·4564	0·54
,, 19	...	13 0 10	+55 29	0·4668	0·4671	0·51

In No. 3946 of the same journal, Prof. Pickering reports that on a spectrogram taken with an objective prism at the Harvard College Observatory on April 16, the nearly continuous spectrum shows a slight increase of intensity at two points, the distribution of the light being the same as that recorded on a similar spectrogram of comet 1898 VII.

The comet was independently discovered by M. Lucien Rudaux at his private observatory at Donville (Manche) on April 16. Using a portrait lens of 4 cm. aperture, he photographed the region about the nebula M92 with an exposure lasting from 10h. 15m. to 10h. 45m. (Paris M.T.), about 4 hours before Mr. Brooks discovered the comet at Geneva (U.S.A.). On developing the plate he discovered an unknown nebulous patch to the north of the nebula, but cloudy weather prevented him from confirming his discovery (*Astronomische Nachrichten*, No. 3946).

THE STABILITY OF SOLAR SPECTRUM WAVE-LENGTHS.—In a paper published in No. 19 (1904) of the *Comptes rendus*, M. Hamy again refers to the apparent change of wave-length of the green cadmium line at λ 508, with the conditions under which the radiation is produced. He states that on increasing the temperature surrounding the vacuum tube from 295° to 310° C., the relative intensities of the single line and the doublet, referred to by Prof. Fabry (*Comptes rendus*, cxxxviii. p. 854), are considerably modified, so much so that the mean wave-length is appreciably altered.

He then suggests that a change of mean wave-length of this character may largely affect the stability of the wave-lengths of lines in the solar spectrum, because the conditions of radiation in the solar atmosphere are probably considerably modified during the various epochs of solar disturbance.

VARIABLE STAR OBSERVATIONS.—The variable star observations made at Rousdon by the late Sir Cuthbert Peek have been edited by Prof. H. H. Turner, and the work is now ready for press. At the meeting of the Royal Astronomical Society held on April 8, Prof. Turner stated that on subjecting the few available light curves to harmonic analysis, he found that the different harmonics appear to form a regular series. Another point of interest discovered was that on subjecting the sun-spot activity curve, obtained by plotting Wolf's numbers, to similar analysis, the coefficients fitted fairly well into the formulæ obtained from the Rousdon star variations if the sun-spot *maxima* be taken as corresponding to the variable star *maxima* (*Observatory*, No. 344).

PROVISIONAL RESULTS OF THE INTERNATIONAL LATITUDE SERVICE.—Prof. Albrecht publishes in No. 3945 of the *Astronomische Nachrichten* the provisional results obtained by the International Latitude Service during 1903–4. From a diagram and a table, which show the variation of the momentary pole from the position of the mean pole, it is seen that the amount of this variation increased during 1903, and is now probably near its maximum value.

THE TISSUE-LYMPH CIRCULATION.[1]

AFTER paying a warm tribute to the memory of his teacher in physiology, the late Prof. Sharpey, F.R.S., the lecturer proceeded.

I propose to submit to you the results of a study on the circulation of the tissue fluid in man, or, in other words, on the fluid transfers between the blood and the tissues. Apart from its intrinsic physiological interest this subject has important bearings on the practice of medicine.

Some of the conclusions suggested to me by this inquiry

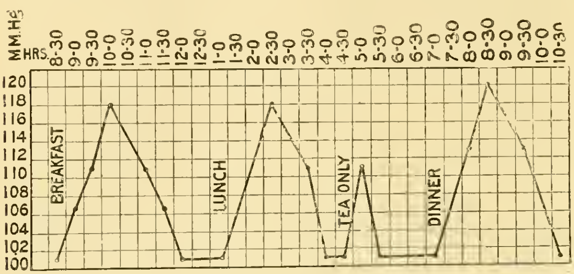


FIG. 1.—Chart showing rise of arterial pressure after food.

were so unexpected that I was naturally led to repeat my observations in every department of it over and over again, and to scrutinise all the facts with more than ordinary diligence. More than 3000 observations have been made in health and disease, but I propose in these lectures to use mainly the physiological material.

METHODS AND APPARATUS.

[Dr. Oliver here described the methods and apparatus employed with certain improvements in the hæmocytometer, hæmoglobinometer, and hæmodynamometer.]

THE EFFECT OF THE INGESTION OF FOOD ON THE TISSUE-LYMPH CIRCULATION.

Elsewhere[2] I have shown that the ingestion of food initiates an interesting series of variations in the blood and blood pressures which culminates in a prolonged wave-like exudation of tissue-lymph, and that this excitation in the circulatory system recurs with perfect regularity after each meal. Subsequent inquiry has amply confirmed this position.

The digestive variations in the blood pressure.—The ingestion of food invariably raises the arterial blood pressure (Fig. 1). In an hour after a meal it rises 15 or even 20 millimetres of mercury, then it begins to fall, and in from two and a half to three and a half hours it becomes stationary until the next meal or until exercise is taken. The curve of the venous pressure rises and falls throughout with that of the arterial pressure. It may, I think, be inferred from these facts that the capillary blood pressure follows the same curve after meals, for we know that this pressure is more closely related to the venous than to the arterial, and that if both these pressures rise or fall together we may fairly assume that the capillary pressure will also rise or fall. After food the pulse-rate also increases, and in an hour it may have gained from eight to fifteen beats a minute. When the pulse pressure gauge is applied so as to arrest the pulsation of the radial artery (the finger being used as the indicator), the reading becomes cardiometric, and is generally increased in an hour after a meal from 15 to 20 millimetres of mercury. Therefore it would seem that digestion very considerably stimulates the heart, augmenting the output and the contractile energy of the ventricle.

The essential aim of the digestive excitation of the circulatory system is to raise the capillary blood pressure, and according to my observations this end is attained by the increased activity of the cardiac muscle. But it can likewise be secured by taking with a meal some substance which dilates the arteries and arterioles, and thus lowers the arterial pressure; then the venous pressure is greatly increased, and the capillary pressure must be raised, being between two pressures higher than the normal capillary pressure.

We may therefore infer that we may have a rise in the capillary pressure either with an increase or a decrease of the arterial pressure according as we have cardiac stimulation (as after meals) or vaso-dilation.

DIGESTIVE VARIATIONS IN THE BLOOD.

I have followed three series of alterations in the blood during digestion, namely, in the corpuscles, in the hæmoglobin, and in the specific gravity. As the variations in the chromocytes and in the hæmoglobin are identical, they are taken together.

Digestive variations in the corpuscles and haemoglobin.—The finger, having been subjected to the compression of the rubber rings, yields blood which shows a progressive rise in the percentages of the corpuscles and of the hæmoglobin until an hour has elapsed, when the increment amounts to from 8 to 10 per cent.; then the percentages gradually fall,

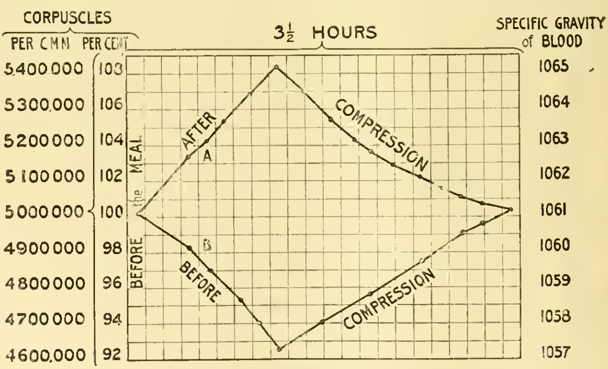


FIG. 2.—Chart showing the percentages of corpuscles and the specific gravity of the blood before and after compression. Observations made before a meal and at frequent intervals afterwards.

and they finally settle down to normal in from two and a half to three and a half hours (Fig. 2, A). Should, however, the blood be derived from the finger in the ordinary way (without compression), the successive readings of the blood elements indicate a progressive fall in the percentages, which in an hour amounts to from 6 to 8 per cent., when a rise sets in and recovery is eventually established (Fig. 2, B).

Digestive variations in the specific gravity of the blood.—The blood, as shown by compression of the finger, rises in

[1] Abstract of the Oliver-Sharpey Lectures on Recent Studies on the Tissue-lymph Circulation, by Dr. George Oliver. Delivered before the Royal College of Physicians of London on April 12 and 14.

[2] *Proceedings* of the Royal Society, June 11, 1903; *The Lancet*, October 3, 1903, p. 940; and the *Journal* of the British Balneological and Climatological Society, 1903.

specific gravity after meals, the rise reaching its maximum point (*e.g.* from 1061 to 1065) in an hour. The specific gravity then begins to fall, settling down to the initial point at the conclusion of the wave-like disturbance (Fig. 2, A). On the other hand, the blood derived from the finger uncompressed affords a specific gravity which follows the contrary course, that is to say, it falls and then rises (Fig. 2, B). When the digestive disturbance is over, the variations in the blood, like those in the circulation, cease, and the readings in normal subjects at rest continue to be alike in both samples (before and after compression) until the following meal.

The digestive exudation of tissue lymph.—On reviewing the foregoing data it is obvious that they indicate strictly concurrent events. All the four series of variations follow exactly the same curve. What is the link which binds them together? If we suppose that the ingestion of food in some way raises the capillary blood pressure which exudes a filtrate of a portion of the liquor sanguinis into the areolar spaces, all the changes in the blood which I have described will naturally follow (see Fig. 2). In proportion to the exudation under a rising capillary blood pressure, the blood will become more and more concentrated in chromocytes and in hæmoglobin, and inasmuch as its specific gravity mainly depends on the corpuscles, the density of the blood will rise *pari passu* with the increased concentration. Then, when the capillary pressure begins to fall, as it does after the acme of the digestive disturbance has been attained, the concentration of the blood diminishes, and we may assume that either absorption of the watery elements of the effused lymph overbalances exudation or that the effusion is being returned by the lymphatics to the blood. Now I have shown that none of these alterations in the blood could have been ascertained by the examination of blood derived from the finger in the ordinary way; they only become apparent after the compression of the tissues by the rubber rings, which removes the extra-capillary fluid and enable us to obtain the blood undiluted by that fluid. But the progressive readings of the ordinary samples of blood, though valueless, and actually misleading when accepted as independent testimony of blood changes during digestion, become instructive when compared with the readings of samples obtained after compression, for they then afford a measure of the amount of fluid withdrawn from the blood. The differential readings of the hæmocytometer tubes made every fifteen minutes after a meal show the greatest divergence, and therefore the largest quantity of tissue fluid, just at the time (an hour after a meal) when the digestive blood pressure wave and the concentration of the blood attain their maximum development. The difference, indicated by the scale on the tubes, will amount to from 15 to 20 per cent.; it will then gradually diminish, and will finally disappear in from two and a half to three and a half hours, and will not reappear until after the next meal or until exercise is taken. The amplitude and duration of the lymph wave are influenced by various conditions, such as the tone of the subject, the bulk and nature of the meal, the use of beverages, rest, or exercise.

Other rhythmical digestive variations.—I will now direct your attention to other physiological variations produced by the ingestion of food, synchronous with the foregoing. These are:—(1) the digestive curve of augmented respiratory exchange determined by Fredericq and other observers; (2) the gastric juice curve of Pawlow; and (3) a digestive rhythmical variation of muscular contractility, which came to light while studying the effects of muscular tension on the arterial pressure. It was found that when tissue-lymph was not apparent (*e.g.* before meals), the tension raised the arterial pressure to a maximum degree (*e.g.* 40 mm.), whereas when the lymph was fully effused (an hour after a meal) the pressure could only be slightly raised (5 or 10 mm.). The digestive curve of muscular contractibility (*i.e.* the capability of being contracted) is therefore the reverse of the lymph curve, and it is inferred that the exudation of the lymph into the muscular tissue checks the shortening of the muscular fibres, and thus diminishes the effect of their contraction on the intramuscular vessels.

These observations on the condition of the muscles during digestion, therefore, confirm the teaching as to the outflow and absorption of lymph furnished by the differential examination of the blood. At the termination of the digestive disturbance there is apparent a gain in the contractile energy, as expressed in an additional rise of the arterial pressure produced by muscular tension. This gain (which only becomes evident after the absorption of the lymph) varies from 5 to 20 millimetres, according to the nature of the food consumed and the need for recuperation.

The effects of typical meals on the digestive lymph flow.—Let us now study the digestive curves of lymph exudation produced by four different kinds of meals. First, the ordinary mixed meal containing the usual proportions of animal food, vegetables, and farinacea; secondly, the meat meal, consisting of animal food in various forms, with cheese and butter and a very little toast; thirdly, the vegetable meal, with farinaceous puddings, fruit, and cheese; and fourthly, the milk meal, milk, bread, and farinaceous puddings. In each case the fluid supplied was a tumbler of water, and the amount of food was merely limited by a feeling of satisfaction. Sugar and salt (two grams of each) were taken in the same quantity at all the solid meals. The meal was at one o'clock, and the same subject was throughout submitted to observation. No exercise was permitted for an hour before and after meals, nor until the digestive disturbance had quite subsided. Observations were made just before the meals and every fifteen minutes after them. The results are epitomised in the following table (Table I.):—

TABLE I.

The meal	Lymph effusion: Maximum per cent.	Lymph effusion: Duration hours
Roast meat	30·0	5
Mixed	17·5	3
Vegetable	12·5	3
Milk	7·5	$1\frac{1}{2}$

You see that the lymph curves produced by these several kinds of meals vary enormously in amplitude and length, and in the following descending order:—meat meal, ordinary meal, vegetable meal, and milk meal. The net gain in muscle contractility shown by the tension test after the subsidence of the digestive disturbance and the removal of the lymph is in the same order, expressed by the following figures:—15 (meat meal), 10 (ordinary meal), 7 (vegetable meal), and 3 (milk meal). Some light will be thrown on these results by studying the effect of the separate food elements.

The effect of the food elements on the production of tissue lymph.—I will first mention those substances which, according to my observation, do not alter the blood pressure or cause the flow of tissue lymph:—cold water, starch, fats, gelatin, proteid as represented by myosin or egg-albumin, the sugars (cane sugar, glucose, maltose, galactose, mannose, dextrose, and inulin), pepsin, and hydrochloric acid. Cold water (*e.g.* 500 cubic centimetres, or a little more than 16 ounces) has no effect, but the same amount of warm water lowers the arterial pressure. This is therefore a temperature effect. In regard to proteids, I selected chemically pure myosin (muscle proteid) and white of egg as representative of the group. So far their effects have been negative. In support of this conclusion we have also the fact that the lymph exudation produced by a meal of roast beef is 30 per cent., whereas that caused by a meal of boiled meat is only 7 per cent. All the sugars named also produce negative results. There are, however, other sugars (glycogen, lævulose, and lichenin) which have been found decisively to affect the blood pressure and the flow of lymph.

Inorganic salts.—I will here only refer to sodium and potassium chlorides, as my observations on the effects of other salts are not sufficiently advanced for publication. Sodium chloride, in percentages varying from 1·5 to 2·0, invariably raises the arterial pressure and increases the outflow of tissue lymph; four grams produce in thirty minutes the exudation of 15 per cent. lymph, which is completely absorbed in thirty minutes more. Potassium chloride lowers the arterial pressure, four grams producing a fall of from 10 to 12 millimetres of mercury. Sodium chloride increases and potassium chloride diminishes the digestive curves. When these two salts are taken in equal proportions—*e.g.* two grams of each—their effects on the blood pressure and lymph flow neutralise each other.

Muscle extractives.—The lymph exudation produced by home-made beef-tea, derived from half a pound of beef infused first in cold water and then in hot, is similar in amplitude to that of a meat meal (see *supra*), only it is of shorter duration. Two well known beef extracts, selected out of several as typical of the rest, gave a somewhat smaller amount of lymph exudation, the quantities taken being those directed by their proprietors. No salt or other seasoning was added to the preparations. The following products derived from muscles have been administered, dissolved or suspended in six ounces of cold water:—creatin, creatinin, xanthin, hypoxanthin, uric acid, carnin, and glycogen.

[Dr. Oliver here described how the matter of dosage was settled.]

The doses thus worked out may seem to the experimental physiologist to be absurdly small, but the uniform results obtained in different subjects showed that it was not necessary to experiment with larger quantities. My observations show that uric acid (either as uric acid or as ammonium urate), xanthin, creatinin, carnin, and glycogen produce a decided rise in the blood pressures (arterial, capillary, and venous) and increase the exudation of tissue lymph, the pressure and the exudation rise being proportionate to each other. This effect from ingesting glycogen was quite unexpected. The accompanying table gives the doses, the maximum lymph exudation and arterial pressure, and the duration of these effects.

TABLE II.

	Maximum rise		Duration of effect in minutes
	Lymph per cent.	Arterial pressure mm. Hg	
Carnin, gram 0·0325 (½ grain)	15	115	30
Creatinin, gram 0·0325 (½ grain)	14	114	30
Glycogen, gram 0·0325 (½ grain)...	6	106	23
Ditto, gram 0·13 (2 grains)	20	120	90
Uric acid, gram 0·0325 (½ grain)...	17	117	85
Ammonium urate, gram 0·13 (2 grains)...	25	125	110
Xanthin, gram 0·0325 (½ grain)	20	120	105

A long latent interval (about twenty minutes) elapsed after swallowing uric acid or ammonium urate and xanthin before any effect on the blood pressure was apparent, a fact which may be accounted for by the low solubility of these products, which, however, produced effects more decided and more prolonged than those which followed the other products. Creatin and hypoxanthin differ from the other allied products in their effects on the arterial pressure. Creatin produces at first a fall which is followed by a rise, and hypoxanthin causes a marked fall in the arterial and an equally decided rise in the venous pressure.

When xanthin is combined with it in equal parts, the blood pressures remain unaltered. In like manner when creatinin is taken with creatin (equal parts) the preliminary fall of arterial pressure produced by creatin fails to appear, and the effects of the two agents balance each other for twenty minutes, after which the rise of creatinin combined with the ultimate rise of creatin take their normal course. All the muscle-derived products raise the capillary blood pressure, increase the exudation of tissue lymph, and are cardiac stimulants.

The active principles contained in beverages.—Allied to most of the foregoing products in their chemical constitution and physiological action on the blood pressure and lymph circulation are the active principles of tea, coffee, and cocoa, caffein and theobromin being methylxanthins, the former being called tri- and the latter di-methylxanthin. They are therefore bodies with a purin basis (C_5N_4), and, like most of the other purin bodies, they raise the blood pressure in a long, well sustained curve, with an accompanying wave-like exudation of tissue lymph, and they are also like the other purins in being cardio-stimulants.

The effects of alcohol on the blood pressure and lymph circulation are modified very considerably by the presence of other constituents in spirits, wines, malt liquors, &c. The arterial pressure curve of absolute alcohol at first falls and then rises, the fall below the normal being equivalent to the rise above it. It therefore resembles that of creatin, and differs from that of xanthin, uric acid, creatinin, and glycogen.

Whisky follows the compound curve of absolute alcohol; brandy, wines, and beer conform to the simple curve of the bodies just mentioned, and gin follows the curve of hypoxanthin, this marked difference being due to the juniper it contains.

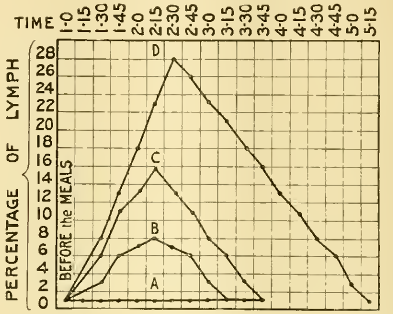


FIG. 3.—A, lymph record from purin-free meal. B, purin-free meal with sodium chloride 2·0 grams. C, purin-free meal with sodium chloride 4·0 grams. D, purin-free meal with sodium chloride 2 grams and uric acid 0·016, creatin 0·033, creatinin 0·033, xanthin 0·016, hypoxanthin 0·016, and glycogen 0·048.

I conclude from the foregoing data that caffein, theobromin, and the alcoholic beverages (but more especially brandy, wines, and malt liquors) excite the flow of tissue lymph like the purin and the other products previously mentioned.

HOW IS THE DIGESTIVE EXUDATION OF TISSUE LYMPH PRODUCED?

We are led by the foregoing data to the following conclusions:—(1) That the food constituents themselves (proteids, fats, and carbohydrates) do not possess the power of starting the mechanism by which lymph is dispensed to the tissues throughout the body. (2) That nature, however, associates with our food-stuffs small quantities of certain very active substances which bring into play that mechanism, though these substances themselves are practically devoid of food value; and that man frequently increases this natural lymph stimulation by the use of salt and beverages containing bodies which also incite the flow of lymph.

But let us put this matter to the test of experiment. It is possible to arrange a meal containing a fairly large quantity of nutrient elements in such a way that it will not react on the circulation at all, and will not induce the flow of tissue lymph. Such a meal consists of three or more eggs, a full supply of white bread, boiled rice or tapioca, cream, sugar, and cheese, with a tumbler of cold water. I have taken this meal several times with the feeling of repletion, and yet it has not produced a rise of blood pressure or the slightest flow of tissue lymph.

In Fig. 3 A shows the negative effect of this meal on the tissue lymph; B and C indicate two exudations produced by adding two and four grams of sodium chloride to the meal; and D is a voluminous lymph wave resulting from the addition of a mixture of the following products with two grams of salt:—uric acid, 0·016 gram; creatin, 0·033 gram; creatinin, 0·033 gram; xanthin, 0·016 gram; hypoxanthin, 0·016 gram; and glycogen, 0·048 gram. The meal produced a much more refreshing and sustaining effect when the digestive lymph flow was excited by the addition of salt, and more especially by that of salt associated with the physiological products than when taken alone.

Exercise.

The fundamental effects of exercise on the blood pressure may be readily studied in an epitomised form by placing the pad of the hæmodynamometer over a small superficial artery, like the superficialis volæ, and then throwing all the muscles into a state of tension for sixty seconds (the arm on which the observation is made being excluded from the contraction). In Fig. 4 you observe that the complete arterial pressure curve of muscular contraction is made up of two elevations, (A) primary and (C) secondary, separated by a fall (B) which is just as decidedly below the normal pressure as the second rise is above it. The first elevation (A) is synchronous with the tension, and the second (C) appears after the muscles are relaxed.

Now these oscillations of the arterial pressure are all seen on a larger scale in ordinary exercise, each stage being, of course, prolonged in proportion to the duration of the exercise. The primary rise is invariably followed by a gradual fall, even during the continuance of the exercise, and by a rapid and decisive fall on its cessation, and that fall is succeeded during rest by a second rise.

Sir Lauder Brunton and Dr. Tunnicliffe are, I believe, the only observers who have furnished trustworthy data on the blood pressure in man, both during muscular movement and immediately after its cessation, and their data accord with my own.[1]

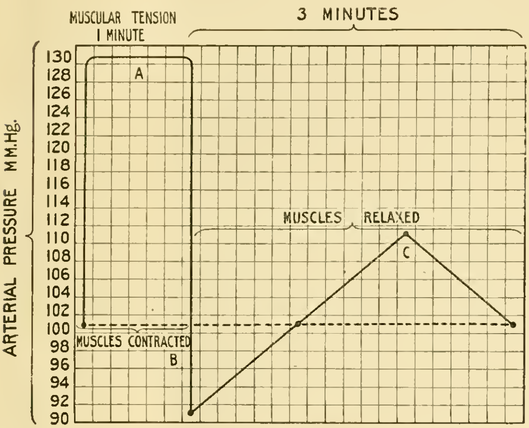


Fig. 4.—The effect of muscular tension on the arterial pressure; (A) rise from muscular tension; (B) fall on relaxing the muscles; (C) secondary rise during rest.

The secondary rise of blood pressure which I have invariably found to supervene during rest after exercise does not, however, seem to have been recognised by other observers.

Exercise invariably increases the exudation of tissue-lymph. Inasmuch as it is rapidly absorbed on the cessation of exercise, the observation must be made without delay.

How are these effects of exercise produced? According to Ludwig and Gaskell (Ludwig's "Arbeiter," 1877), during a short tetanus the flow from the efferent vein of the muscle, after the first spurt of blood, may fall to practically *nil*. Therefore we may infer that muscular contraction causes partial or temporary occlusion of the intra-muscular vessels, and that this increase of peripheral resistance, along with reflex cardiac stimulation, will go far to explain the rise in the arterial pressure.

At the same time, the capillary pressure within the muscle will fall, and lymph will not be exuded. But the state of the circulation is different in the non-muscular parts, for all the blood pressures (arterial, capillary, and venous) are markedly raised during the sustained tension of the muscles. Hence the effusion of lymph in the finger. On the other hand, when the contraction ceases, the intra-muscular capillary pressure will rise, and lymph will then be effused into the muscles. That the muscles when relaxed after contraction become full of blood is shown by the work of Ludwig and his pupils, and by Sir Lauder Brunton and Dr. Tunnicliffe, who have furnished graphic evidence of the dilatation of the intra-muscular arteries which follows contraction (*op. cit.*).

As after food so after exercise the contractibility of the muscles (as indicated by the tension test) diminishes in proportion to the amount of lymph effused.

Exercise likewise provides us with some instructive facts as to how tissue-fluid is removed. Observation has shown that a short muscular contraction of sixty seconds will produce two effusions, one during the contraction which is entirely absorbed in sixty seconds, and another which is immediately afterwards thrown out, and disappears just as quickly, so that in four minutes we have two successive effusions which entirely clear up. The rapidity with which lymph disappears from the tissues in a state of rest certainly favours the notion of absorption rather than that of transmission along the lymphatics. Now, experimentation on animals has shown that muscular action of some kind is necessary to ensure a flow of lymph along the lymphatics, so we may conclude that during exercise the muscular action will more particularly favour that passage for the lymph.

Fatigue.

Observation has shown that the rise in the arterial pressure produced during the continuance of exercise becomes less and less pronounced in proportion to the duration of the exercise; for example, the initial increase of from 15 to 20 mm. gradually subsides until, after the lapse of a certain time (which varies with the tone of the individual and with the external temperature), the arterial pressure will not exceed 100 mm. Hg, and if the exercise is further continued it will even fall lower, to 95, 90, or 85 mm. This point was also observed by Sir Lauder Brunton and Dr. Tunnicliffe.

Why should the rise of pressure, normally induced by exercise, be effaced or even replaced by a fall when exercise is prolonged?

Inasmuch as the lymph exuded during exercise obstructs the contractile pressure of the muscular fibres on the intra-muscular arteries and arterioles, the peripheral resistance caused by exercise will be reduced, and the arterial pressure will gradually fall. In fatigue, no amount of will exerted over the muscles can raise the arterial pressure at all; the muscles, though capable of ordinary contraction, become, as it were, lymph-logged. But massage quickly disperses the lymph, and the contractibility is restored. Human instinct, without knowing the "why," practised what is now taught by physiological inquiry. We read in the "Odyssey" how the women rubbed and kneaded their weary heroes returned from battle, and thus invigorated them, and we know that from time immemorial rubbing was the sovereign remedy for fatigue.

The physiology of fatigue includes another important factor, namely, diminished gravity control over the blood pressure. The outcome of exercise is the production of hypotonia in the vaso-motor mechanism, which is the central fact, as it were, of fatigue.

Rest.

During rest after exercise there is developed a steady and persistent rise of the blood pressures and a corresponding effusion of lymph, and the volume and duration of this second outflow of lymph are always proportionate to the vaso-dilator or reducing effect of exercise. The physiological intent of it is to repair and recharge the muscles,

[1] "Remarks on the Effect of Resistance Exercises upon the Circulation in Man, Local and General," by Sir Lauder Brunton and F. W. Tunnicliffe, M.D. (*Brit. Med. Journ.*, October 16, 1897.)

for after the lymph is absorbed the contractibility is always found to be restored. How are the muscles thus automatically renovated without food? It seems highly probable that the reparative lymph exudation which follows exercise is produced by the agency of chemical substances generated by muscular contraction, just as the digestive lymph flow is caused by exogenous lymphagogues. Creatin and lactate of ammonium produce the double curve of arterial pressure induced by exercise and rest.

Sleep.

A large volume of lymph (not less than 20 per cent.) is exuded into the somatic tissues during sleep.

In sleep the arterial pressure falls very low (from 78 to 82 mm. Hg) and the venous pressure rises to a high point (40 to 50 mm. Hg). There is complete physiological vaso-motor relaxation, consequently the veins not only of the somatic, but of the splanchnic area are filled with blood. The splanchnic stasis is shown by the fact that when a weight (a shot bag of 14 lb.) is applied to the abdomen, the arterial pressure is raised at once from 80 to 100 mm. Hg. In a few minutes, however, when the subject is fully awake, the arterial pressure rises to 95 mm. Hg or so, the venous pressure falls to 15 or 20 mm. Hg, the shot bag no longer raises the arterial pressure, and the effused lymph of sleep, having become absorbed, is no longer apparent.

What is nature's intent in thus supplying the tissues so liberally with lymph during our sleeping hours? The answer admits of no doubt—restoration; and how true to fact is the old proverb, "He who sleeps, dines"! For during sleep nature provides the maximum amount of tissue-lymph, which we only obtain intermittently after meals. Can this be proved? The answer is provided by the tension test.

[Dr. Oliver here epitomised the results of a night and morning record, demonstrating in figures the restorative power of sleep.]

[The effects of gases (oxygen, carbonic acid, sulphurous acid, sulphuretted hydrogen, and the atmosphere of sewers), of gravitation, of temperature, and of internal secretion (supra-renal, thyroid) on the tissue-lymph circulation were described, and the vexed question as to whether tissue-lymph is a secretion or a pressure product was discussed.]

Is there an intermediary circulation?—The rapid removal of lymph from the tissues when the muscles are at rest, for example, after exercise and on awaking from sleep, suggests absorption rather than transmission by the lymphatics. Therefore I think there is evidence in support of a circulation of fluid independent of the lymphatic circulation, though controlled by the capillary circulation, of which it may be said to be an extension.

There is not time to discuss the forces involved. The best account of them, as at present known, is that given by Prof. Starling, of University College, than whom no one has done more valuable work in support of Ludwig's pressure theory (Schäfer's "Text-book of Physiology," vol. i.). Ludwig pointed out that the prime factors in the effusion of lymph are filtration and diffusion. My observations refer only to filtration, and they suggest such a scheme of the intermediary circulation as is represented in Fig. 5, which shows the mechanism, as it were, for the supply of pabulum to the tissues (AA) and for the removal of soluble waste from them (BB). The view there represented explains why the ingestion of food restores the tissues at once, and long before the food itself can be assimilated into the blood. The exhausted tissues have not, therefore, to remain unsupplied until the food becomes part of the common store of pabulum, which the blood keeps ready for distribution. Each supply of food may be viewed as a deposit paid to our banking account, but it is not merely a deposit, for nature combines with it a cheque for payment; the banker therefore is compelled to reimburse at the same time that he receives, so that the balance is kept fairly uniform.

In normal subjects each effusion of tissue-lymph is intermittent, rising out of and subsiding into an apparently lymph-free state of the tissues when the capillary blood-pressure (as indicated by the venous pressure) touches its minimum point. Probably at such times some trace of tissue fluid is actually present, but insufficient to be made apparent by the ordinary use of the differential test.

[Some practical deductions were here drawn, and new remedies suggested by the inquiry were described.]

There is much more work to be done, but meanwhile let me summarise a few provisional conclusions:—

(1) Tissue-lymph is intermittently effused, for example, after the ingestion of food, during exercise, rest after exercise, and during sleep.

(2) The rapid effusion and removal of it in states of rest suggest the existence of a circulation between the blood and the tissue spaces—a circulation independent of the lymphatic circulation.

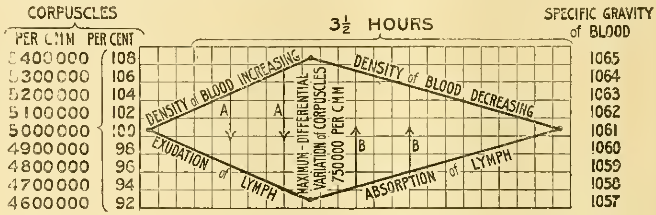


Fig. 5.—Schema showing (AA) exudation of lymph conveying proteids and salts to the tissues and (BB) absorption of tissue fluid containing soluble waste and salts.

(3) The apparent physiological intent of the effusion is reparative, and that of its absorption to aid the removal of tissue waste.

(4) By studying the conditions which increase or decrease lymph effusion, we ought to gain a clearer insight as to how to control derangements of nutrition and metabolism.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Mr. Hubert M. Turnbull, Magdalen College, Oxford, has been elected to a Radcliffe travelling fellowship for three years.

The Rede lecture at Cambridge will be delivered on June 11 by Dr. J. A. Ewing, F.R.S., upon "The Structure of Metals."

Dr. F. G. Donnan, lecturer in chemistry in the Royal College of Science, Dublin, has been elected to the chair of physical chemistry recently founded by Sir John T. Brunner in the University of Liverpool.

The *British Medical Journal* states that the new medical laboratory of the University of Pennsylvania is to be opened on June 30. Exclusive of site and equipment, the building has cost nearly 140,000*l*. It is the first of a group of buildings it is proposed to erect, which when completed will, it is hoped, form the largest system of buildings devoted to the teaching of medicine in the world.

As a general result of the various movements in recent years to establish a centre of veterinary education in Liverpool, it has been arranged, we learn from the *Times*, that Prof. Williams, of the New Veterinary College, Edinburgh, shall transfer his teaching centre to Liverpool and take up the professorship of veterinary medicine and surgery offered by the Institute of Comparative Pathology, and shall act as principal or dean of the veterinary school. Prof. Williams will be placed upon the same footing as professors in the university, and the cost of the professorship has been privately guaranteed for a period of years. In accordance with a scheme drawn up five years ago by

the professors of pathology, physiology, zoology, and botany, veterinary students will be taught in their respective laboratories, and will enjoy, without increase of fees, all the facilities possessed by medical and science students. They will, in addition, have the advantage of the Tropical Medicine, Cancer Research, and Comparative Pathology Schools. This arrangement will provide for the scientific training of the veterinary student upon a scale equal to that of the medical student.

At the concluding meeting of the session 1903–4 of the Architectural Association, Mr. A. E. Munby read a paper on the value of science in an architectural curriculum, in which he urged that science should receive more attention from architectural students. He mentioned some interesting particulars as to the number of hours per week devoted to science by students studying in architectural courses in the great technical schools of the world. To give a few examples, Mr. Munby stated that the architectural student at McGill University devotes 7·9 hours a week to science classes; at University College, London, 6·8; at Glasgow Technical College, 5·3; at the University of Illinois, 4·9; and at the Technischen Hochschule, 2·5. To conclude his paper, Mr. Munby made suggestions as to the subjects of science an architectural student should study at the outset of his career. These should include, he thought, a general experimental course on physics, including laboratory work; a similar course dealing with the elements of inorganic chemistry; and a short course outlining the principles of geology and dealing with the stratigraphical arrangement of rocks and with petrology. The whole of this work might be undertaken by a person of average intelligence at the age of, say, sixteen, and completed in one year with some twelve hours' teaching per week.

In connection with the recent opening of the new buildings, extending the South-Western Polytechnic at Chelsea, the heads of the electrical and mechanical engineering departments have prepared a pamphlet describing the aims and equipments of their respective laboratories. In these laboratories two classes of students receive instruction, viz. those who attend the engineering day courses and those who form the evening classes. The standard of the courses extends far enough to include preparation for the engineering degree of the University of London, and attention is given to the requirements of candidates for the associate membership of the Institution of Civil Engineers. But no particular syllabus is followed, and students are able easily, if necessary, to take other public examinations in engineering. So far as funds have permitted, an attempt has been made to provide in the mechanical engineering laboratory more than one type of some pieces of apparatus, in the belief that the range of experience thus gained by a student is of value, while such a variety enables a number of students to be less thickly distributed over the apparatus. Many of the larger pieces of apparatus have not been specially designed for experimental purposes, but are ordinary standard commercial machines which have been fitted with the necessary measuring appliances by students and the workshop instructor. The electrical engineering laboratories are divided into three principal rooms—the large laboratory where the testing of electrical instruments and the measurement of electrical quantities are carried out; the dynamo room where the experiments and investigations on dynamos and motors are conducted, and the "advanced" laboratory where the standard instruments are kept and used for calibrating the instruments used in experimental work, and where the more advanced alternating and polyphase current experiments are made. In addition to these rooms, there are two rooms fitted up for photometric tests on incandescent and arc lamps respectively. There is also a large wiring shop for instruction in practical wiring and jointing, and two workshops for repairing and making apparatus for the electrical laboratories. There are in all six steam engines specially fitted up for experimental work. Recently, when the electric lighting plant had to be duplicated, advantage was taken of the opportunity for fitting the new engines with measuring appliances, so that experiments could be carried out on them whenever desired. The plant available permits of the setting aside of either of the new engines for experiment, or the unit experimented upon can be made to provide electrical energy for lighting the building (Fig. 1). The pamphlet contains a full description, with illustrations, of all the more important pieces of apparatus in both departments of engineering.

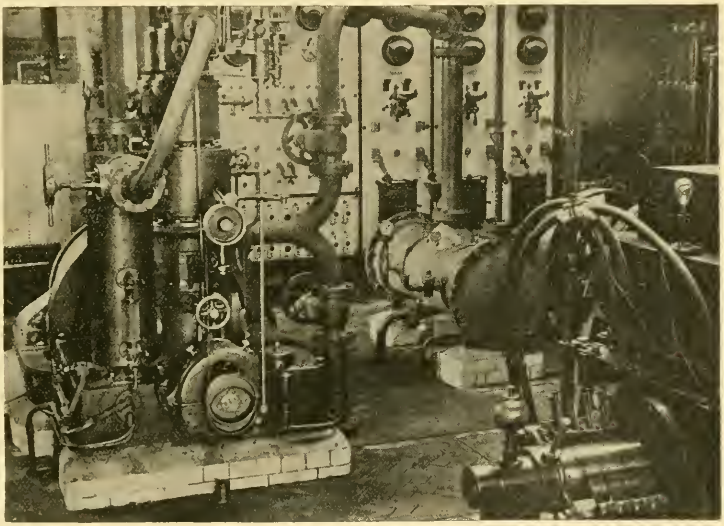


Fig. 1.—Main Lighting Plant of the South-Western Polytechnic.

SOCIETIES AND ACADEMIES.

London.

Royal Society, April 28.—"The Effects of Changes of Temperature on the Modulus of Torsional Rigidity of Metal Wires." By Dr. Frank **Horton**.

An account of some experiments performed at the Cavendish Laboratory with the view of ascertaining as accurately as possible the manner in which the modulus of torsional rigidity varies with the temperature. The metals experimented on were copper, iron, platinum, gold, silver,

aluminium, tin, lead, cadmium, all chemically pure, and also specimens of commercial copper and of steel pianoforte wire. A dynamical method of experimenting was employed, the torsional oscillations of the wire under test being timed by a method of coincidences capable of great exactness. The method of coincidences is usually only applied to the comparison of two nearly equal times, but it is shown to be equally applicable to any two periods, even if they are quite different. Observations were made, in general, at five temperatures, viz. at the temperature of the room, about 10° C., at 35° C., 55° C., 75° C. and 100° C., and also in some cases at 126° C., the higher temperatures being obtained by using the vapours of various liquids boiling under atmospheric pressure. The coefficients of expansion of the wires used (which are required in order to compare observations at different temperatures) were determined by means of the measuring bench in the physical laboratory of the University of Birmingham. The internal viscosities of the wires, and the effect of increased amplitude of vibration, were also investigated. The main observations for the rigidity determinations were all taken at an average amplitude of fourteen minutes.

The following is a summary of the principal results:—

(1) In all the materials examined, with the exception of pure copper and of steel, the modulus of rigidity at one temperature is not constant, but increases as time goes on.

(2) The diminution of the modulus of rigidity per degree rise of temperature between 10° C. and 100° C. is constant for pure copper and for steel, but not for any of the other materials examined.

(3) In general, the effect of heating to a high temperature is to increase the value of the rigidity modulus at lower temperatures.

(4) The internal viscosity of all the metals examined, with the exceptions of soft iron and steel, increases with the temperature. The internal viscosity of soft iron decreases rapidly with rise of temperature, and reaches a minimum value at about 100° C. There is a slight decrease also in the case of steel.

(5) Repeated heating and continued oscillation through small amplitudes decrease the internal friction.

(6) Both the internal friction and the period of torsional vibration increase with the amplitude of oscillation.

(7) Vibration through a large amplitude considerably alters both the logarithmic decrement and period of oscillation at smaller amplitudes.

(8) The internal viscosity of a well annealed wire suspended and left to itself gradually decreases.

"On the Sparking Distance between Electrically Charged Surfaces." By Dr. P. E. **Shaw.**

Recent investigation (1901) on this subject has been made by R. F. Earhart, who used voltages from 1000 to 38, the corresponding distances being from 100 microns to $\frac{1}{4}$ micron. In the present paper the voltages range from 150 to $\frac{1}{8}$, and the distances of discharge from 1 micron to 1/500 micron. The instrument used to measure these small distances is the electric micrometer, which works on the principle of electric touch, and is therefore specially suitable to measurements of this kind.

The relation between voltage and sparking distance is found to be linear, and direct from the origin; hence it is evident that there is no change in dielectric strength in any film or films existing on the surfaces of the solid bodies used at the points of discharge. Since 1 volt or thereabouts is so frequently employed in electric circuits, there is especial interest in knowing the sparking distance for this voltage; it is about 1/100 micron, and unless sufficient pressure is used to squeeze out dust or films until the metal surfaces approach to this distance, no current can pass.

The two surfaces used for discharge are a bead and a plane, generally of polished iridio-platinum. The pressure used is atmospheric. In working with such minute distances care must be taken to exclude extraneous vibrations, and the surfaces must be re-polished after every discharge except when the voltages are less than 10. In every case the discharge is observed by a telephone suitably shunted.

Geological Society, April 27.—Dr. J. E. Marr, F.R.S., president, in the chair.—On a new species of Eoscorpius from the Upper Carboniferous rocks of Lancashire: W. **Baldwin** and W. H. **Sutcliffe.** The specimen described was found in an ironstone-nodule occurring on a fairly well marked horizon, about 135 feet above the Royley Mine (or Arley Mine) coal-seam, at Sparth Bottoms, south-west of Rochdale Town Hall. The nodules occur in a band of blue shale, in which are well preserved remains of *Carbonicola acuta*, ferns, Calamaria, *Prestwichia rotundata*, and *Bellinurus bellulus*. The animal is well represented by both the intaglio and relievo impressions; these, however, only show its dorsal aspect. The specimen is referred to a new species. Dr. Peach is of opinion that the ancient species visited the sea-shore in search of the eggs of invertebrates, and the association of this new scorpion with king-crabs at Sparth Bottoms is in favour of this view.—The genesis of the gold-deposits of Barkerville (British Columbia) and the vicinity: A. J. R. **Atkin.** The gold-bearing area of Cariboo is roughly confined, within a radius of 20 miles of Barkerville, to the band of crystalline rocks known as the Cariboo schists, generally assigned to the Lower Palæozoic group. The veins follow the strike but not the dip of the rocks; the gangue is similar to that associated with the nuggets in the placers. While all the reefs carry gold, none have been found rich enough to account for the placer-gold. The placer-gold has probably been derived from the enriched outcrops of the veins which once existed above water-level. Such enrichment is due to the leaching out of pyrites leaving the less soluble gold in lighter quartz, and to actual enrichment by precipitation. While the enriched zone was being formed, the weathering of the surface kept removing the leached outcrop, and constantly exposing fresh surfaces to atmospheric influences. To the weathering of these outcrops the rich placers are attributed. The denudation of the reefs and the deposition of gold in the gravels appear to have taken place in Tertiary times.

Zoological Society, May 3.—Mr. G. A. Boulenger, F.R.S., vice-president, in the chair.—Mr. Oldfield **Thomas,** F.R.S. read a paper on the osteology and systematic position of the rare Malagasy bat *Myzopoda aurita*.—Mr. F. E. **Beddard,** F.R.S., read a third of a series of papers on the anatomy of the Lacertilia, which dealt with points in the vascular system of chamæleon and other lizards.—A communication was read from Mr. A. D. **Imms** containing notes on the gill-rakers of the ganoid fish Polyodon.—Dr. W. G. **Ridewood** read a paper on the cranial osteology of the fishes of the families Elopidæ and Albulidæ, with remarks on the morphology of the skull in the lower teleostean fishes generally.

Entomological Society, May 4.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. W. J. **Kaye** exhibited a piece of the plant *Eupatorium macrophyllum* from British Guiana, attractive to Lycorea, Melinæa and Mechanitis species of that region, and a remarkable larva-like twig of birch. The resemblance was so complete that even the head, the segments, the appressed legs and the anal claspers appeared to be represented. It had been found on Oxshott Heath while searching for larvæ of *Geometra papilionaria*. He also exhibited on behalf of Mr. C. P. Pickett a pupa of *Rumia crataegata* which had spun up in an empty pupa case of *Pieris brassicae*. The latter was on the roof of a breeding-cage, and the geometrid larva had completely crept inside to spin its cocoon.—Mr. J. E. **Collin** exhibited *Corethra obscuripes*, v. d. Wolf (?=*C. fusca*, Staeg.), a little known species of the genus, and new to the British list, which he had found in some numbers at Newmarket. Mr. G. T. **Porritt** exhibited a living larva of *Agrotis ashworthii*, of which species he had found considerable numbers on one of the mountains of Carnarvonshire during the last week in April.—Commander J. J. **Walker,** R.N., exhibited a gall sent him by Mr. Harold S. Mort, identified by Mr. Froggart as *Brachycelis duplex*, Schrader, and found at Wentworth Falls, Blue Mountains, N.S.W., where it was by no means common.—Mr. G. H. **Verrall** exhibited three specimens from the Hope collection at Oxford of *Neoitamus cothurnatus*, Meig., an Asilid not previously recorded as British. They were taken near Oxford by Mr. W. Holland. He also stated that the Anthrax exhibited at the last meeting on behalf of Mr. R. G. Bradley was *A. circumdata*, Meig., a species recorded before, but not observed for more than fifty years past.—

The **President** exhibited a Longicorn beetle captured near Malvern, Natal, by Mr. C. N. Barker, together with a large Bracon from the same locality, to which, on the wing, it showed a close superficial resemblance.—Mr. H. J. **Turner** exhibited living larvæ and cases of several species of the lepidopterous genus Coleophora, and contributed notes on them.—Dr. A. Jefferis **Turner** communicated a paper entitled "A Classification of the Australian Lymantriadæ."—Dr. F. A. **Dixey** read a paper by Major Neville Manders, R.A.M.C., entitled "Some Breeding Experiments on *Calopsilia pyranthi*, and Notes on the Migration of Butterflies in Ceylon."

Chemical Society, May 5.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The following papers were read:—The slow combustion of ethane: W. A. **Bone** and W. E. **Stockings.** The hydrocarbon is first oxidised to acetaldehyde, the latter then passes into formaldehyde, and this is eventually oxidised to carbon dioxide, carbon monoxide and steam.—The action of radium rays on the halides of the alkali metals, and analogous effects produced by heat: W. **Ackroyd.** The γ-rays from radium bromide produced no colour change with lithium chloride, but with sodium, potassium, rubidium and cæsium chlorides produced yellow, violet, bluish-green and green transitory colorations respectively. These changes are analogous to the thermal effects produced in other substances, and are probably like these purely physical.—The mutarotation of glucose and galactose. Solubility as a means of determining the proportions of dynamic isomerides in equilibrium: T. M. **Lowry.** The author has applied the method already used in the case of β-bromonitrocamphor to these sugars, and finds that the stereoisomerides are approximately equally stable, and are present in about equal proportions in solutions. A study of the substitution products of *ar*-tetrahydro-α-naphthylamine. 4-Bromotetrahydro-α-naphthylamine and *ar*-tetrahydro-α-naphthylamine-4-sulphonic acid: G. T. **Morgan,** Miss F. M. G. **Micklethwait** and H. B. **Winfield.** Studies in the tetrahydronaphthylamine series, part ii., halogen derivatives of *ar*-tetrahydro-β-naphthylamine; part iii., reaction between *ar*-tetrahydro-β-naphthylamine and formaldehyde: C. **Smith.** A description of the derivatives obtained in these reactions.—The resin acids of the Coniferæ, part i., the constitution of abietic acid: T. H. **Easterfield** and G. **Bagley.** A description of the various decomposition products of abietic acid is given; a study of these led the authors to the conclusion that this resin acid is a decahydroretenecarboxylic acid, and they suggest that in retene the methyl and *iso*propyl groups occupy a *meta* position relatively to each other.—Additive products of benzylideneaniline with ethyl acetoacetate and ethyl methylacetoacetate: F. E. **Francis** and Miss M. **Taylor.** These additive products are shown to exist in one form only.—Studies on ethyl carboxyglutarate, part i., action of acids on ethyl sodiocarboxyglutarate: O. **Silberrad** and T. H. **Easterfield.**—Studies on optically active carbimides, part i.: A. **Neville** and R. H. **Pickard.**—The comparison of the rotation values of methyl, ethyl and *n*-propyl tartrates at different temperatures: T. H. **Patterson.** It is shown that a connection between the rotation values of these esters may be traced when the comparison is made at corresponding temperatures.—Note on the action of hydrogen sulphide on formaldehyde and acetaldehyde solutions: J. **Drugman** and W. E. **Stockings.** A description of a number of complex thio-derivatives obtained in these reactions.—The viscosity of liquid mixtures: A. E. **Dunstan.** The effects of the chemical affinity, molecular aggregation, and to some extent of the chemical constitution of the constituents on the viscosities of liquid mixtures are discussed.—The conversion of *iso*propyl alcohol into *iso*propyl ether by sulphuric acid: F. **Southerden.** In opposition to the experience of previous investigators, the author has obtained a small yield of *iso*propyl ether by this reaction.

Royal Astronomical Society, May 13.—Prof. H. H. Turner, F.R.S., president, in the chair.—The secretary gave an account of a paper by Dr. **Downing** on the definitive places of the standard stars for the northern zones of the Astronomische Gesellschaft, and also of two papers by Mr. **Cowell** on the moon's errors in longitude.—A brief account was given of a second series of double star measures by the Rev. T. E. **Espin.**—The **Astronomer Royal** read a paper on the new Greenwich micrometer for measurement of photographs of Eros. As the measures were required for determination of the solar parallax, a greater degree of accuracy was necessary than for the Astrographic Chart. A new instrument was therefore constructed, on the lines of Mr. Hinks's Cambridge measuring machine, and the results obtained with it were extremely satisfactory, the measures being remarkably accordant. The micrometer was described and illustrated by photographs shown on the screen.—Mr. **Franklin-Adams** read a paper on his photographic chart of the heavens, to Argelander's scale $1^{\circ} = 20$ mm. After much preliminary work and an extended series of experiments, a 10-inch photographic lens was made by Messrs. Cooke and Sons from designs by Mr. Dennis Taylor, and this was provided with a specially constructed mount of the English form, with two guiding telescopes instead of one, and various other improvements. The instrument was taken to the Cape in June, 1903, and by the kindness of Sir D. Gill was erected in the grounds of the observatory. The work of photographing the southern heavens on 115 plates, each 15 inches square, with two hours' exposure, was practically completed, as well as a set with triple exposures, and another taken with a 6-inch lens. The star images were very good, even towards the edge of the plates, the lenses having proved extremely satisfactory, and the driving arrangements specially good. Photographs of the instrument and specimens of the plates were shown on the screen.—Mr. **Bellamy** gave an account of his paper on a new cluster in Cygnus, and other papers were taken as read.

PARIS.

Academy of Sciences, May 16.—M. Mascart in the chair.—The president announced to the Academy the loss by death of M. Marey, member of the section of medicine and surgery, and of M. Sarrau, member of the section of mechanics. The death of Prof. Williamson, correspondant for the section of chemistry, was also announced.—The cooling power of a feebly conducting fluid current on a body limited in every direction: J. **Boussinesq.**—On the electrolysis of calcium chloride: H. **Moissan.** A reply to some criticisms of M. Bullier with reference to a claim for priority.—The effect of small oscillations of temperature on a system affected by hysteresis and viscosity: P. **Duhem.** Small oscillations of external action and of temperature have no appreciable influence on the transformation of a system when the coefficient of viscosity of this system is large with respect to the amplitude of the oscillations.—Researches relative to the resistance of the air made by means of a new apparatus called the dynamometric balance: Ch. **Renard.** Two different forms of apparatus are described, the simple balance, which permits of the calibration of wind vanes for dynamometers, and the double balance, specially employed in the study of helices. Three illustrations are given.—On the function of the *n*-rays in causing changes of visibility in feebly illuminated surfaces: Jean **Becquerel.** The conclusion is drawn from the experiments described that the change in the distinctness and luminosity of feebly lighted surfaces submitted to the action of the *n*-rays is probably to be attributed, at least in great part, to a variation in the sensitiveness of the vision arising from the *n*-rays directed on the surfaces, and not to an appreciable variation in the light emitted.—The explanation of some colour phenomena shown by a tube containing rarefied gas: H. **Pellat.**—On the microscopic state of the poles and the discharge spectra: B. **Eginitis.**—On the density of aqueous saline solutions considered as an additive property of the ions, and on the existence of some hydrated ions: P. **Vaillant.**—A new method for the exact determination of the molecular weights of the permanent gases; the atomic weights of carbon, hydrogen and nitrogen: Ph. A. **Guye.** The author, with M. Friderich, has previously established that the van der Waals equation leads to the relation $V_m(1+a)(1-b) = R$, where V_m represents a gram-molecule at 0° C. and under the pressure of one atmosphere, a and b the two constants of the equation of fluids with respect to unit volume, and R the gas constant. In the present paper R is replaced by $R - mT_c$. By applying this relation to the experimental results of Leduc, Morley and Rayleigh, the values of the atomic weights of hydrogen,

carbon and nitrogen are determined. For the last named element the mean value is 14·004, as against the figure of 14·057 of Stas.—On the preparation and properties of hypophosphorous acid: C. **Marie.** Two methods are given, starting from the barium and sodium salts respectively, both of which yield a pure crystalline acid of melting point 26·5. The decomposition by heat was also studied, and the equation ordinarily accepted for this change shown to be erroneous.—On a crystallised chromous tartrate: G. **Bauge.**—Colouring matters derived from triphenylmethane: Charles **Lauth.**—The preparation of the α-β-ketonic esters: L. **Bouveault** and A. **Wahl.** A study of the reaction between nitrogen peroxide and ethyl isonitrosoacetoacetate.—The action of phosphorus trichloride and some primary cyclic amines at the boiling point; the reduction of the chloride with the formation of phosphorus: P. **Lemoult.**—On some new polymers of formaldehyde: A. **Seyewetz** and M. **Gibello.**—The action of paraformaldehyde upon the sesquiterpenes: P. **Genvresse.** Carophyllene, clovene and cadinene all combine with formaldehyde.—Researches on the mechanism of the circulation of aromatic compounds in plants: Eug. **Charabot** and G. **Laloue.**—The action of heat and acidity on amylase: P. **Petit.**—The organisation and morphogeny of the Ætheridæ: R. **Anthony.**—Observations on Gymnoascus and Aspergillus: P. A. **Dangeard.**—Some remarks on the ancient Cryptogams and fossil plant soils: B. **Renault.**—Study of the spinal cord by means of the *n*-rays: André **Broca** and A. **Zimmern.** From their preliminary observations the authors conclude that the examination of the spinal cord by means of the *n*-rays allows of the demonstration on the living man of the existence of medullary centres, and even to gain some idea of their degree of activity.—On the presence of geminal nuclei in the cells of certain tissues of the guinea pig: Maurice **Pacaut.**—Light, food, and chlorophyll as modifying factors in the development of Amphibia: Georges **Bohn.**—On a mode of bacterial extraction of spring and river water by means of fine sand: P. **Miguel** and H. **Mouchet.**

DIARY OF SOCIETIES.

THURSDAY, May 26.

Royal Institution, at 5.—Literature and the State: H. G. Wells
Institution of Electrical Engineers, at 8.—High Speed Electric Railway Experiments on the Marienfelde-Zossen Line: Alexander Siemens.

FRIDAY, May 27.

Royal Institution, at 9.—The Progress of Oceanography: H.S.H. Albert Prince of Monaco.
Physical Society, at 5.—The Law of Action between Magnets and its bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers: Dr. C. Chree. F.R.S.—On the Ascertained Absence of Effects of Motion through the Ether in Relation to the Constitution of Matter on the FitzGerald-Lorentz Hypothesis: Prof. J. Larmor, Sec.R.S.—On Coherence and Recoherence: Dr. P. E. Shaw and C. A. B. Garrett.

SATURDAY, May 28.

Royal Institution, at 3.—Spitsbergen in the 17th Century: Sir W. Martin Conway.

MONDAY, May 30.

Royal Geographical Society, at 8.30.—A Journey to the North of the Argentine Republic: F. O'Driscoll.

TUESDAY, May 31.

Royal Institution, at 5.—The Solar Corona: H. F. Newall, F.R.S.
Society of Arts, at 4.30.—The Economic and Industrial Progress and Condition of India: J. E. O'Conor.

WEDNESDAY, June 1.

Entomological Society, at 8.
Society of Public Analysts, at 8.—The Analysis of Condensed Milk: J. B. P. Harrison.—Roasted Beetroot: E. G. Clayton.—A Collection of Readings with the Zeiss Oleo-Butyrometer: William Chattaway and C. G. Moor.—Note on the Estimation of Sugars and Starch in Vegetable Substances: John S. Ford.

THURSDAY, June 2.

Royal Society, at 4.30.—*Probable Papers*:—On the Aurora Borealis and the Electric Charge of the Sun: Prof. S. Arrhenius.—Colours in Metal Glasses and in Metallic Films: J. C. Maxwell Garnett.—On a Direct Method of Measuring the Coefficient of Volume-elasticity of Metals: A. Mallock, F.R.S.—A Method of Measuring Directly High Osmotic Pressures: The Earl of Berkeley and E. G. J. Hartley.—The Advancing Front of the Train of Waves Emitted by a Theoretical Hertzian Oscillator: Prof. A. E. H. Love, F.R.S.—On the General Circulation of the Atmosphere in Middle and Higher Latitudes: Dr. W. N. Shaw, F.R.S.—On the Magnetic Changes of Length in Annealed Rods of Cobalt and Nickel: Shelford Bidwell, F.R.S.—On the Electric Effect of Rotating a Dielectric in a Magnetic Field: Dr. Harold A. Wilson.
Royal Institution, at 5.—Literature and the State: H. G. Wells.
Linnean Society, at 8. The Species of Impatiens in the Wallichian Herbarium: Sir Jos. D. Hooker, G.C.S.I., F.R.S.—Biscayan Plankton. Part III. Chætognathia: Dr. G. H. Fowler.—The Flow of Fluids in Plant-stems: Prof. R. J. Anderson.
Rontgen Society, at 8.30.—Experiments to Determine the Effects of Form and Winding upon Resonance Phenomena: Dr. Clarence A. Wright.
Institution of Mining Engineers, at 11 a.m.—Suggestions respecting the Institution of Mining Engineers: Prof. R. A. S. Redmayne.—Coal-mining in the Faroe Islands: G. A. Greener.—Tin-mining in the Straits Settlements, with a few Notes regarding Chinese Labour: W. T. Saunders.—Underground Temperatures, especially with regard to Coal-mines: Dr. Hoefer.—The Hammer-Fennel Tachymeter-theodolite: A. O. Eoll.—Notes on the Report of the Departmental Committee on the Use of Electricity in Mines: Sydney F. Walker.—A Comparison of Three-phase and Continuous Currents for Mining Purposes: Roslyn Holiday.—Electric and Compressed-air Locomotives: B. S. Randolph.—Work of Conveyors on Longwall Faces: Robert G. Ware.
Chemical Society, at 8.—*iso*Nitrosocamphor: M. O. Forster.—Imino-Ethers and Allied Compounds corresponding with the Substituted Oxamic Esters: G. D. Lander.—The Action of Heat on α-Hydroxycarboxylic Acids: Part I. α-Hydroxystearic Acid: H. R. Le Sueur.—The Basic Properties of Oxygen. Additive Derivatives of the Halogen Acids and Organic Compounds and the Higher Valencies of the Oxygen. Asymmetric Oxygen: E. H. Archibald and D. McIntosh.

FRIDAY, June 3.

Royal Institution, at 9.—The Development of the Theory of Electrolytic Dissociation: Prof. Svante Arrhenius.
Institution of Mining Engineers, at 10.30 a.m.—The Firing of Babcock Boilers with Coke-oven Gases: T. Y. Greener.—Explosives and Lamp Testing Station at Frameries: Victor Watteyne.—The Transvaal Kromdraai Conglomerates: A. R. Sawyer.—The Southern Rand Goldfield: A. R. Sawyer.—The Occurrence of Cinnabar in British Columbia: G. F. Monckton.—Prevention of Accidents in Winding: John H. Merivale.—Petroleum and its Use for Illumination, Lubricating and Fuel Purposes: P. Dvorkovitz.—The Analytical Valuation of Gas Coals: G. P. Lishman.—A New Process of Chlorination for Mixed Gold and Silver Ores: H. F. Brown.—Graphite-mining in Ceylon and India—Part I. Ceylon: G. A. Stonier.

SATURDAY, June 4.

Royal Institution, at 3.—Spitsbergen in the Seventeenth Century: Sir W. Martin Conway.

CONTENTS.

THURSDAY, JUNE 2, 1904.

SIR WILLIAM FLOWER.

Sir William Henry Flower, K.C.B., &c.; a Personal Memoir. By C. J. Cornish. Pp. xi+274; illustrated. (London: Macmillan and Co., Ltd., 1904.) Price 8s. 6d. net.

THAT the life of a man of the social and scientific position of the late director of the natural history branch of the British Museum should be written, and written, moreover, by a master of popular literature, will, we think, be admitted on all hands, and in tendering a hearty welcome to this record of a distinguished career and a fine character, we trust we shall be expressing the views of no inconsiderable section of the public, and of all our readers. Mr. Cornish, whose name needs no introduction of ours to the reading public, has been fortunate in securing the cooperation of several members of the late Sir William's family in the compilation of the memoir before us, so that all the details with regard to early life and family history may be accepted as thoroughly authentic. The first two chapters, dealing with the period ending with the return from the Crimea, are, indeed, written by Mr. Victor Flower, Sir William's youngest son, while the final chapter of the biography, describing the closing scenes, is from the pen of his widow, Lady Flower. Nor is this by any means all in the way of contributions by members of the family to the biography, for the eldest daughter of Sir William, Mrs. Shann, takes the public into her confidence with regard to family life in the well known house adjacent to the Museum of the Royal College of Surgeons, while another daughter, Mrs. Biddulph, communicates a note on the summer holidays of the Flower family in early days. No critic can therefore complain of any lack of breadth in the lines upon which the biography has been drawn up; we have, indeed, not only the life-history of the central figure, but a large amount of information with regard to the family generally.

The memoir, as the author says in his preface, is essentially a personal one, and does not in any way claim to give an account of Sir William's scientific work, which must remain for a future biographer.

Although the biography of a scientific man in which there is no detailed reference to, or criticism of, the work from which he gained his reputation reminds us of the well known saying in regard to the play of "Hamlet," yet, if we may judge from what little he has attempted in this line, Mr. Cornish has been decidedly well advised in confining himself in the main to the personal aspect of his subject. When, for instance, he strays even such a short distance away from this track as to compile a list of Sir William's scientific papers, he displays a lamentable carelessness and a lack of knowledge of both the principles of bibliography and of zoological nomenclature. The want of accuracy in matters of this nature is indeed displayed even on the title-page of his memoir, where we find Sir William described as president of the *Royal* Zoological Society.

To justify our assertion as to the want of care displayed in the compilation of the list of scientific papers and books given in one of the appendices,[1] we need only refer, in the first place, to the following "misprints," as we suppose they must be euphemistically termed. On p. 252 we have, for instance, *Hylobatus* for *Hylobates*, *syndactilis* for *syndactylus*, and *javenicus* for *javanicus*. On the following page, and elsewhere, we find *Physalius* for *Physalus*, on p. 254 *geoffrensis* for *geoffroyensis*, and on p. 256 *Helitherium* for *Halitherium* and *arnuschi* for *arnuxi*. Nor are such errors confined to the appendix, for in the text (which is wholly the author's) we find on p. 121 Etteridge for Etheridge, and on p. 175 *Hyperodon* for *Hyperöodon*. In the case of the bibliography, at any rate, such errors (at which no one would have been more annoyed than Flower, who was the very spirit of accuracy in such matters) might have been easily detected by checking the list with the Royal Society's "Catalogue of Scientific Papers."

Nor is this all, for we find want of uniformity in regard to the references to the serials in which the papers originally appeared. For instance, we have on p. 257 *Journ. Anth. Inst.* and on p. 258 *Anthropol. Inst. Journ.*, while on the latter page we find *Zool. Soc. Proc.* as the equivalent of *Zool. Soc. Proc. London* on p. 260. Again, we should much like to know the meaning, so far as the Roman numerals are concerned, of the following entries on the page last mentioned, viz. "Zool. Soc. Proc. London, 1884, cxi. p. 417," and "Zool. Soc. Proc. London, 1884, xi. p. 206."

Reverting to the book itself, we find the fourth and fifth chapters devoted to the period during which Flower was officially connected with the Museum of the Royal College of Surgeons. Here the author records the energetic manner in which Flower set himself to work to render the museum more useful to students, and the inventions he devised for the better display or more convenient handling of the specimens exhibited. Family life during this period forms the subject of chapter vi., while in the following chapter we are introduced to some of Sir William's personal friends, among whom were Dean Stanley, Prof. Huxley, and the late Duke of Argyll. Chapters ix. to xiii. treat of the second portion of Sir William's official career, during which he was head of the museum in the Cromwell Road. Here, in the main, the author records very fairly the changes and improvements introduced gradually and tactfully during Flower's administration, dwelling especially on the installation of the "index museum" and the other contents of the central hall, and also directing attention to the better manner of displaying specimens introduced under the new *régime*. We fail, however, to understand the meaning of the sentence on p. 149, in which it is recorded that

"In 1898 the rearrangements of the mammals on Flower's system were nearly completed for the classes Chiroptera (bats), Edentata, and Primates."

As a matter of fact, the provisional arrangement of all the orders (not classes) had been by that time com-

[1] The list is stated to have been compiled by Mr. Victor Flower, but the author must be held responsible for its inaccuracies.

pleted (so far as anything in a museum can be said to be complete), while the Edentata, which was one of the first groups taken in hand, had been arranged at least a couple of years previously.

Limitations of space forbid fuller notice, and we may conclude by mentioning that while special chapters are devoted to his favourite subjects, anthropology and cetaceans, the three final chapters deal with the later and closing scenes of Sir William's life. Of four excellent portraits, those taken in his later years serve to remind old friends of Flower's striking personality. Bearing in mind the limitations already mentioned, the author is decidedly to be congratulated on the attractive manner in which he has laid before the public the main features of a very interesting and highly successful scientific career. R. L.

THE IDENTIFICATION OF ORGANIC COMPOUNDS.

A Method for the Identification of Pure Organic Compounds. Vol. i. By S. P. Mulliken, Ph.D. Pp. xii+364. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 21s. net.

THIS is the first of a series of volumes which are intended to facilitate the identification of organic substances. The scheme commonly, though not invariably, adopted by organic chemists in this connection is to determine the molecular formula of the compound under investigation, and then to refer to Richter's "Lexicon," in which all known organic compounds are tabulated according to their molecular formulæ. Further agreement is established by a comparison of physical and chemical properties. The author considers that the difficult technique of conducting an ultimate organic analysis, upon which the above system mainly depends, "is fully mastered only by long practice," and that there is a shorter cut to the same result. This short cut consists in finding, in the first instance, to what class of compounds—hydrocarbon, alcohol, aldehyde, acid, &c.—the substance belongs, and, when this has been done, in determining such simple physical characters as melting-point, boiling-point, specific gravity, colour, smell, &c., which will lead to its identification. It is therefore necessary for purposes of reference that all the known organic compounds should be grouped into separate classes. This is what the author has done. In each class the individual members are arranged in the order of increasing boiling-point or melting-point. For example, let us suppose that the substance, the identity of which is required, proves to be an acid. All the known organic acids are divided into tables of liquid and solid acids, and these again into categories, which are either soluble or insoluble in water. Suppose that the acid under investigation is a liquid which is soluble in water. Having turned to the table containing the liquid acids soluble in water, an examination of the first column of boiling points will lead, perhaps, to the discovery of one corresponding to the unknown acid. Under this compound a series of characteristic reactions are described which will enable the investigator to fix the identity of his compound by means of a few simple tests.

There is very little that is new in the above method. It is one which is adopted, consciously or otherwise, by the majority of chemists, whether they possess the skill requisite to conduct an ultimate organic analysis or not. That carefully elaborated methods are at present in use for determining the constitution of a substance by chemical tests is clearly shown by the existence of such a volume as Hans Meyer's, which has been translated into English, and has already reached a second edition.

In point of fact, when a substance has been obtained in a state of purity, its identification is as a rule not a serious undertaking. The character of the substance from which it is derived will usually furnish a clue to its nature, and a few characteristic tests will soon set the matter at rest. If the identification of a compound is a crucial matter, few chemists would rest content with anything less than a direct comparison of the product with the known substance, for melting- and boiling-points are apt to vary a little with the apparatus and form of thermometer employed, and colour reactions do not always produce quite the same tint unless the conditions of the experiment are the same.

It is the separation of a compound from a mixture and its purification which make the greatest demands on the skill and experience of a chemist. Compared with this, an ultimate organic analysis and the characterisation of a compound by chemical tests offer little difficulty.

There is no intention to disparage the labour which has been expended on this work. The careful revision of the reactions of many of the substances found in the tables would entitle the book to grateful recognition, in addition to which there is much useful and practical information on the method of applying the different reactions which every organic chemist will appreciate. It would be incorrect, moreover, to state that the tables will not serve the object for which they have been compiled. The question is only whether the object is worth the labour which it entails, seeing that most of the information may be derived indirectly from other sources.

The biological system of classification of substances into orders, genera and species cannot be commended. It is unnecessary and undesirable. There is no analogy in the application of these terms in the two sciences, and their use may be misleading. Chemical nomenclature still suffers in this country from such a false analogy, when *radicle* was adopted in place of *radical*. J. B. C.

THE MIND OF THE CHILD.

Educational Psychology. By Edward Thorndike, Adjunct Professor of Genetic Psychology in Teachers' College, Columbia University. Pp. vii + 177. (New York: Lemcke and Büchner, 1903.)

THIS volume embodies the results of investigations in which Prof. Thorndike has interested himself and his pupils for some time past, applying the methods

of experimental psychology to educational problems. Seeing that it is the first serious treatise on the subject which has yet appeared, such a pioneer work naturally deserves warm welcome and temperate criticism, even though there be important points of detail, both in the methods employed and in the conclusions drawn, which can hardly be accepted without reservation. As Prof. Thorndike ably points out in the last five pages of his book, there are numerous problems and experiments described by him which any trained teacher "can attack with a fair promise of success." His obvious aim in publishing this work at the present primitive stage of genetic psychology is to encourage a greater number of workers in the field of research with which he has so closely identified himself in the United States. For this reason, doubtless, he has omitted all consideration of the comparative data already available in other countries than his own.

The first two chapters are devoted to the methods of measurement and to the statistical distribution of mental traits within the community. The view is upheld that "the distribution of any mental trait in a homogeneous species undisturbed by selection is that given by the probability integral." It is to be regretted that the author has not devoted more space to statistical methods. Such sentences as the following, on p. 20, are surely unwise:—"The mathematical formulæ by which this is done need not concern us here." "Here again the mathematical formulæ are best omitted. The reader may take it on trust that such a transposition as the following is correct."

The third chapter concerns the correlation between different mental abilities in the same individual. An endeavour is made to define the certainty with which any scholar who is especially proficient in one subject of study will surpass or fail to reach the average in other subjects. It is experimentally shown that the phrase "ability in arithmetic" is "but an abstract name for a number of partially independent abilities."

The remaining chapters are concerned with experimental work upon the connection of mental traits with sex and age, upon the relation between mental and physical traits, and upon the influence of heredity and environment. Within the limits of this notice it is impossible even to summarise the many highly interesting results of the experiments of the author and his countrymen. As the author observes,

"The science of education when it developes will like other sciences rest upon direct observations of and experiments on the influence of educational institutions and methods made and reported with quantitative precision. . . . It is the vice or the misfortune of thinkers about education to have chosen the methods of philosophy or of popular thought instead of those of science. We ruminate over the ideas of Pestalozzi or Herbart or Froebel as if writing a book a hundred years ago proved a man inspired. . . . We are like chemists who should quarrel over the views of Paracelsus or Arnauld of Villeneuve. . . . In education everything is said but nothing proved" (p. 164).

This book is a worthy and welcome attempt to apply exact method to educational problems, although it leaves some little to be desired in style and general appearance. CHARLES S. MYERS.

OUR BOOK SHELF.

Précis d'Électricité Médicale, Technique Électrophysiologie, Électrodiagnostic Électrothérapie, Radiologie, Photothérapie. By Prof. E. Castex. Pp. vii + 672; 208 figures. (Paris: F. R. de Rudeval, 1903.)

THE object of the author has been to furnish the medical student with a work which will be useful to him in the present state of electrical knowledge, but the author hopes that it will also not be without value to medical men who are devoting themselves to the special study of electrotherapeutics, and likewise to practitioners who have not had such opportunities.

The work is divided into five different sections, including technique, electrophysiology, electrodiagnosis, electrotherapy, and lastly the study of X- and other rays.

The author has been very successful in the arrangement of his matter, and the physical aspect of the question has not been neglected, judging, of course, from the medical point of view. The various currents employed in medicine, continuous, interrupted, sinusoidal, high-frequency, and static, have all been practically and efficiently explained. The second and third chapters, dealing with electrophysiology and diagnosis, will be found particularly useful to those who desire a practical and not too exhaustive guide. The application of electricity to the diseases of the different organs is described in concise and practical terms, a fact which will be useful to physicians who have not had the advantages of modern training at one of the electric departments which now form a part of most large hospitals. The last chapter, which is devoted to X-rays, occupies something like 120 pages, and cannot, of course, be expected to compete with the larger treatises, such as Bouchard's, recently published. But again Prof. Castex has shown his practical tendency by giving under each heading a short and very useful guide to the interpretation of photographic as well as radioscopic diagnosis, and radiotherapy itself, although briefly treated, has not been forgotten.

The work contains about 208 illustrations, well chosen to assist the student in understanding the theories, instruments, and clinical charts.

A careful perusal of the work will show that it has been written by one who understands his subject and the needs of the student and practitioner. It is concise, thoroughly practical, and just such a guide as should appeal to those for whom the author has written the work. J. M.

Radium and All About It. By S. Bottone. Pp. 96; with four figures and four full-page plates. (London: Whittaker and Co., 1904.) Price 1s. net.

THE appearance of a popular shilling volume dealing with the properties of the salts of radium and the theory of radio-activity may be regarded as an indication of the wide interest that has been aroused by the discovery and investigation of the radio-active elements. There is much to be said in favour of the production of a book that shall satisfy the curiosity of those whose interest has been aroused but whose knowledge of chemistry and physics is insufficient to enable them to follow the developments of the subject in the technical journals. In spite of its rainbow-tinted cover and its somewhat boastful title, the present volume gives a substantially accurate account of the most important phenomena. It contains liberal quotations from the chief workers in the subject, though these are taken chiefly from articles that have appeared in the non-technical journals and reviews. The author appears to have derived his information almost entirely

from English sources, and to have devoted more attention to popular expositions than to the original literature of the subject. The volume is consequently not free from the faults that are almost inseparable from a compilation of this kind, and the arrangement of the matter is in places somewhat confusing. But the author has made a sober and honest attempt to give a simple explanation of a very complex subject, and has attained a fair measure of success. The figures are clearly and simply drawn, and the full-page plates, which include reproductions of the spectra of radium, calcium and helium, and of Sir William Huggins's two series of spectra, are valuable features of the book.

Second Stage Botany. By J. M. Lowson. Pp. viii+452. (London: W. B. Clive, 1904.) Price 3s. 6d.

THE syllabus of the second stage examination in botany of the Board of Education has been judiciously framed on broad lines, and those students generally shape best who possess a reasonable knowledge of the structure and activities of plants and apply that knowledge in their answers. In the preparation of students for this examination the primary object should be to emphasise leading principles, and further to stimulate reflection by making the student observe many facts for himself. Instead of this one finds in the book under notice the usual attempt to supply directly all the information required to answer the manifold questions which are possible, and important facts are lost in the mass of detail. In the latter part of chapter ii., which deals with tissues, the most essential fact is the importance of the vascular tissues as continuous conductive strands, but this is relegated to one of the final sections, which is reached after wading through descriptions of meristems, stereid bundles, sclerotic cells, &c. The chapter on the leaf bristles with terms, including the "incubus" of phyllotaxis, but any suggestions as to the reasons for the variety of form are considered unnecessary. Another defect in the book is the inclusion of antiquated terms and ideas, of which the most noticeable, because it is accompanied by a diagram (Fig. 105), is the existence of centrospheres in Phanerogams. The description of "double-fertilisation" is peculiar; on p. 199 it is stated that the generative cells pass down into the pollen tube, and one cell fuses with the oosphere; "the fate of the other generative cell is described on p. 304." One is tempted to find a correlation between this method of incorporating the result of recent research and the statement which appears in the introduction, that a large portion of this work has already appeared in the author's "Text-book of Botany."

Les Frontières de la Maladie. Maladies latentes et Maladies atteruées. By Dr. J. Héricourt. Pp. xi+285. (Paris: Ernest Flammarion, 1904.) Price 3.50 francs.

ALTHOUGH in well marked cases health and sickness are distinct and opposite conditions, in a large number of instances the boundary between the two is indefinite, the one passing insensibly into the other, and it is with this borderland that the author of the work under review deals. Commencing with dyspepsia, he shows how this may pass on into more grave conditions, and by natural stages finally comes to consider the mild types of such infective diseases as scarlatina, enteric fever, and diphtheria, which in their mildest forms cause little disturbance, and may pass unnoticed and undiagnosed.

Among others, an interesting chapter is devoted to a consideration of how epidemics of disease spontaneously die out. As treating of a little studied branch of medicine, the book is suggestive and to be recommended. R. T. HEWLETT.

LETTERS TO THE EDITOR.

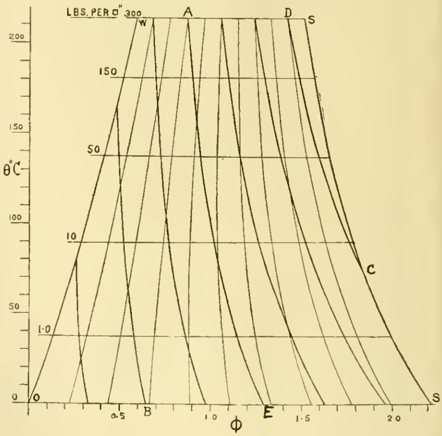
[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of ononymous communications.]*

$\theta\phi$ Lines of Total Heat.

I THINK that $\theta\phi$ diagram curves showing constant total heat, although often drawn by students, have never yet been published, and I venture to ask you to publish a set made more carefully than usual by one of my students, Mr. A. W. Steed. Total heat is intrinsic energy $+ pv$, so that for steam it is what Regnault called his total heat. In the figure I have indicated the pressure, but of course the ordinate is proportional to temperature and the abscissa is entropy. Along OW the stuff is all water. Along SS the stuff is all saturated steam. The thin lines, like AB, show the stuff maintaining the same fractional dryness; for example, along AB the stuff is 0·3 of steam, 0·7 of water. Along the thicker lines, like AE, the stuff has constant total heat.

Many people have the notion that when steam is throttled it is very greatly dried. Of course the drying is greater if

LINES OF CONSTANT TOTAL HEAT "H"



the place of throttling is well protected from loss of heat by a non-conducting covering, and in this case total heat remains constant. Now if the line DC is looked at, it will be seen that steam which is 90 per cent. dry at 300 lb. pressure, if throttled to 150 lb. pressure is about 93 per cent. dry, and if throttled to 50 lb. pressure is about $95\frac{1}{2}$ per cent. dry. Thus the drying effect is not very great.

The effect is evidently more marked with very wet steam. Thus, looking at AE, steam 30 per cent. dry at 300 lb. pressure becomes 42 per cent. dry if throttled to 50 lb.

The lines show at once how much steam at any pressure will result on the Halpin system of storage from each pound of stored hot water. Thus imagine a total heat line from the point W in the figure. A pound of water stored at 300 lb. pressure and reduced to 150 lb. pressure will generate about 0·07 lb. of steam.

I need not mention the other important applications of this diagram. To the right of SS, in the superheated part, lines of constant total heat are horizontal, being lines of constant temperature. JOHN PERRY.

Royal College of Science, South Kensington, S.W.

The Nature of the α Rays emitted by Radio-active Substances.

THE α rays emitted by radium and other radio-active substances have been shown by Rutherford ("Radio-activity," pp. 115–141) to consist of positively charged particles for which $e/m = 6 \times 10^3$. They are rapidly absorbed by gases and solids, the absorption coefficient being approximately proportional to the density of the absorbing medium. The value of the absorption coefficient in air divided by the density varies between 350 and 1300 for different types of α rays. The velocity of these rays is about 1/10th to 1/20th that of light.

It is interesting to compare the properties of these rays with those of kathode rays moving with about the same velocity; e/m for such rays is about 10^7, and the value of their absorption coefficient in air at 1 mm. pressure is 0·85 (Lenard, *Ann. der Phys.*, Bd. 12, p. 714, 1903) when the velocity is 1/10th that of light and 3·9 when it is 1/20th.

The absorption coefficient for these rays is also proportional approximately to the density of the absorbing medium. Dividing 0·85 by the density of air at 1 mm. pressure we get 540,000, and in the same way 3·9 gives 2,500,000. The corresponding numbers for the α rays are about 350 and 1300. Thus we see that the α rays are nearly 2000 times as penetrating as kathode rays moving with the same velocity.

Assuming that $-e$ for the kathode rays is equal to e for the α rays, we have for the ratio of their masses $10^7/6 \times 10^3 = 1700$. It thus appears that the penetrating power of the α rays is to that of kathode rays, moving with the same velocity, approximately as the mass of the α rays is to the mass of the kathode rays. We may conclude from this that an α particle loses as much energy in colliding with an atom as a kathode-ray particle or corpuscle. If we regard the α particles as being of atomic dimensions (that is, as having a radius about 10^{-8} cm.), while an electron or corpuscle only has a radius of about 10^{-13} cm., it is very difficult to understand this result. On the view that all atoms are assemblies of electrons, the fact that the absorption of kathode rays depends only on the density of the absorbing medium is regarded as indicating that the electrons penetrate the atoms and are absorbed by colliding with the electrons which compose the atoms. Since α particles lose the same amount of energy as electrons in penetrating matter, it seems probable that they also penetrate the atoms and lose energy by colliding with the electrons in exactly the same way. If this view is taken, it becomes difficult to regard an α particle as of atomic dimensions, and we may look upon it as a positive electron exactly similar in character to an ordinary negative electron. The mass (m) of an electron is now regarded as being purely electromagnetic in character, and is given by the formula $m = 2e^2/3a$, where a is its radius and e its charge. For a negative electron this gives $a = 10^{-13}$ cm. Regarding an α particle as a positive electron, we get in the same way for its radius about $\frac{1}{2} \times 10^{-16}$ cm. On this view, therefore, the α particles are enormously smaller than the negative electrons.

The properties and modes of occurrence of the α particles are in agreement with the view that they are really positive electrons. For example, they are produced like kathode rays in electric discharges at low pressures (being then known as canalstrahlen), and have very similar properties to kathode rays. The writer therefore suggests the view that α particles may be positive electrons having a radius about 2000 times smaller than negative electrons.

Trinity College, Cambridge. HAROLD A. WILSON.

A Suggested Explanation of Radio-activity.

I AM venturing, in the present note, to add another to the already large number of suggestions as to the meaning of the phenomenon of radio-activity.

It seems to be well established that the apparent instability of the atoms of radio-active substances is not to any great extent dependent on the temperature of the mass; the instability, therefore, is not the outcome of intermolecular collisions. Neither does it seem to arise from an excess of the internal energy of the molecule. For the internal agitation of the molecule, so far as is known, shows itself in the emission of light, and this is associated with high mass-temperature. There is, of course, the possibility, suggested by Prof. J. J. Thomson, that there are internal degrees of freedom not represented in the spectrum of the gas, and that it is the energy of these which forms the starting point of the radio-active process. On the other hand, it is possible that the atomic instability, not being the result of the agitation of the molecules or of the component material parts (ions or corpuscles) of which the molecules are composed, must be traced to the agitation of the ultimate constituents of these ions or corpuscles. If, for instance, we take a definite mechanical illustration, and imagine our universe constructed on the model suggested by Prof. Osborne Reynolds, the source of instability must be looked for in the agitation of the "grains" of which he supposes the ether to be constituted. The velocities of these grains follow Maxwell's law of distribution, so that very high velocities, although rare, are not impossible. It is at least thinkable that a grain moving with exceptionally high velocity may succeed in breaking down the normal piling in its immediate neighbourhood when this is possible (*i.e.*, probably, when in the immediate proximity of matter), and may therefore effect a rearrangement of the adjacent ether structure. A process of this kind would be independent of the mass-temperature; it would, so to speak, depend solely on the ether temperature, which is supposed, on Prof. Reynolds's hypothesis, to be constant throughout space. It seems probable that the rearrangement would consist of the combination and mutual annihilation of two ether strains of opposite kinds, *i.e.* in the coalescence of a positive and negative ion, and would therefore result in the disappearance of a certain amount of mass. There would, therefore, be conservation neither of mass nor of material energy; the process of radio-activity would consist in an increase of material energy at the expense of the destruction of a certain amount of matter.

Apart, however, from this special mechanical model, it seems probable, on grounds of general dynamics, that the ether does not transmit waves in a perfectly unaltered form, and that there is therefore a continual degradation of the energy of regular waves into an energy of random agitation of the ultimate ether structure. This agitation would afford a sufficient cause for the beginnings of the process which results in the breaking up of the atom. Naturally this agitation would have the best chance of effecting a rearrangement when the strain is greatest, and therefore when the ions are most closely packed together. A larger energy of agitation would be necessary when the ions were less closely packed. We should, therefore, expect all matter to be radio-active to some extent, but should expect the greatest amount of radio-activity to be shown by the heavier atoms.

If the instability results from a rearrangement of an ether structure, and not solely of a material structure, we should, *a priori*, on general grounds of physical dimensions, expect the velocity of the ejection to be comparable with the velocity of waves in the ether, this being the only unit appropriate to the measurement of processes depending on the physical constants of the ether. [Just as, for instance, the velocity of a gas streaming into a vacuum might, *a priori*, be expected to be comparable with the velocity of sound in the gas.] The suggested cause of instability is therefore in agreement with the observed velocity of the α particles. J. H. JEANS.

Trinity College, Cambridge.

The First Record of Glacial Action in Tasmania.

IN a recent paper on the Glacial geology of Tasmania (*Quart. Journ.* Geol. Soc., vol. lx. p. 38), I referred to Gould's recognition of Glacial action in Tasmania as not having been directly published. This view I accepted on the strength of the statement by Mr. R. M. Johnston ("The Glacial Epoch of Australasia," *Proc.* Roy. Soc. Tasmania, vol. iv., 1893, 1894, pp. 92–3), than whom no one knows better the geological literature of Tasmania, that it was "through verbal communication to a personal friend of my

own, and one of his (*i.e.* Gould's) early associates, that I first, about 20 years ago, became aware of his discovery of many evidences of glaciation in Tasmania."

I have recently found a Parliamentary Paper, issued in 1860, in which Gould describes his recognition of Glacial action in some of the high valleys of central Tasmania. The passage is as follows ("A Report of the Exploration of the Western Country by Mr. Gould," Parl. Pap., Tasmania, 1860, No. 6):—

"In the Cuvier Valley I was struck, both in going and in returning, by the similarity to the terminal moraine of a glacier presented by an enormous accumulation of boulders which chokes the lower end of the valley, and, somewhat like a dam, extends completely across it, with the exception of the point where it is broken through by the river."

I am glad, therefore, to be able to give to Gould the credit of having published the discovery, which in my paper I could only quote as a verbal tradition.

The Cuvier Valley is one day's journey west of Lake St. Clair. A hut, five miles due west of the top of Mount Arrowsmith, occurs in it. J. W. Gregory.

The University, Melbourne, Victoria, April 25.

The Origin of the Horse.

In your issue of May 19 (p. 53) Prof. T. D. A. Cockerell refers to *Equus caballus celticus*, Ewart, as "still surviving in the pure state in Iceland." Prof. Ewart, in his paper on "The Multiple Origin of Horses and Ponies," says that "the few pure specimens of the Celtic pony survive" in the north of Iceland. I take it that Prof. Ewart does not mean that the northern Icelandic breed of ponies is a pure one, but only that certain individuals of this breed exhibit the "Celtic" characters in a very marked degree. In a recent paper (*Proc.* Camb. Phil. Soc., vol. xii., part iv.) Mr. F. H. A. Marshall and I have brought forward both historical and zoological evidence for the mixed origin of the Icelandic pony. It is perhaps worth noting that the people of north Iceland still claim a social superiority over those of the south as being descended chiefly from the second body of colonists which reached the island. In considering the origin of different breeds of the domestic animals ethnological considerations are often important, and, conversely, the examination of local breeds may sometimes throw light on ethnological problems. For example, in the Malay Peninsula the breed of dogs owned by the majority of the jungle tribes usually classed as Sakais differs from that of the Malay pariah, which has recently been adopted in some cases by Semang tribes and also by those Sakais who live in close intercourse with the Malays. The pariah seems likely to oust the Sakai dog completely, and I am not aware that any zoologist has yet made a detailed examination of the latter, which shows certain resemblances to the local race of *Cyon rutilans*.

Of course, investigations into the ethnological distribution of animals must be made with the very greatest care, for not only may one breed oust or swamp another, but the characters of a single individual may prove so dominant that they may prevail in a great number of cross-bred descendants, and so change the character of a breed in a very short time. This has recently happened in the Færöe Isles. As we know from the statements of Landt ("Description of the Faroe Islands," 1798), there were at least two distinct breeds of dogs in these islands at the end of the eighteenth century, one resembling the modern Danish hound, but smaller; the other a short-legged, rough-haired terrier. The two breeds can still be traced on some of the islands, notably on Naalsoe; but in the neighbourhood of Thorshavn, the capital, great alteration has taken place quite recently. Some ten or twelve years ago a Danish governor introduced a well-bred dachshund dog, which inter-bred with the native bitches. In 1903 I could hardly find a single dog in the town which did not show traces of dachshund ancestry—short, bent legs, long body, &c.—more or less marked. The in-bred highly specialised individual has proved prepotent when crossed with the more or less generalised types which, judging from the statements of Lucas Debes (1623–1670) and Landt, have been somewhat cross-bred for at least two and a half centuries. We are apt to forget factors of the kind when discussing the breeds of domestic animals, and also when investigating the different races of men, but it should be remembered that they are of the very greatest importance in both lines of inquiry. Nelson Annandale.

34 Charlotte Square, Edinburgh.

Insular Races of Animals and Plants.

If we accept the view that species are such by virtue of segregation, and consider subspecies to be groups as yet imperfectly segregated, we seem logically bound to regard insular forms as valid species. According to this way of looking at the matter, a subspecies is in biology what a peninsula is in geography, while a species corresponds to an island. Hence it follows that many subspecies are far more widely distributed and for most purposes more important than many distinct species; just as many peninsulas are more important than the small islands off their coasts.

While it appears illogical to treat insular races as subspecies, there are difficulties in the way of regarding them all as distinct species. In former years, the most distinct were so recognised, and the others were simply ignored. This practice, while it smoothed the way for the systematist, deprived us of the use of a large body of facts of the greatest possible interest to the evolutionist, and the time has come when it must be given up. As a result of the new methods, the number of "species" recognised is increasing very rapidly, as shown, for example, by the description of seventy new Malayan mammals in a single paper by Mr. G. S. Miller, jun. Many of the "species" described in this paper are excessively similar and yet distinguishable, and inhabit different islands. It is evident that one could take a map of the Malay Archipelago and prophesy with some degree of accuracy the number of insular species of Mus and some other genera awaiting discovery by simply counting the islands, eliminating those too closely adjacent. In mountain regions something of the same sort is found, the tops of the mountains or mountain ranges serving the same purpose as islands. For freshwater organisms, lakes and river systems afford similar phenomena, as shown, for example, by the races or species of Salmonidæ.

The objections to the recognition of all these isolated forms as valid species are two. First, their extreme similarity in many instances, and second, the specific name does not indicate the immediate relationships of the form. It has seemed to me that these difficulties might be overcome by the recognition of a new category, for which the name "idiomorph" suggested itself. This name may be objectionable on account of the term idiomorphic, used in crystallography, and it is probable that someone can think of a better. If it is accepted, it may be abbreviated to "id.," as "var." is written for variety, and "subsp." for subspecies.

To illustrate the different methods, we may take certain bats of the genus Chilonycteris, found in the Greater Antilles, using the facts recently published by Mr. Rehn.

C. macleayii group.

	i. (Species).	ii. (Sub-species.)	iii. (Idiomorphs).
Jamaica ...	*C. grisea*, Gosse.	*C. macleayii grisea.*	*C.* (*macleayii* id.) *grisea.*
Cuba ...	*C. macleayii*, Gray.	*C. macleayii.*	*C. macleayii.*
Haiti ...	*C. fuliginosa*, Gray.	*C. macleayii fuliginosa.*	*C.* (*macleayii* id.) *fuliginosa.*
Porto Rico	*C. inflata*, Rehn.	*C. macleayii inflata.*	*C.* (*macleayii* id.) *inflata.*

C. parnellii group.

Jamaica ...	*C. parnellii*, Gray.	*C. parnellii.*	*C. parnellii.*
Cuba ...	*C. boothi*, Gundlach.	*C. parnellii boothi.*	*C.* (*parnellii* id. *boothi.*
Haiti ...	*C.* ?[1]	*C. parnellii?*	*C.* (*parnellii* id.)?
Porto Rico	*C. portoricensis*, Miller.	*C. parnellii portoricensis.*	*C.* (*parnellii* id.) *portoricensis.*

[1] Doubtless exists, but not yet discovered.

The proper name of the idiomorph would be a binomial, the name of the superspecies being inserted when advisable, just as subgeneric names are inserted, within brackets.

T. D. A. COCKERELL.

Colorado Springs, Colorado, U.S.A., May 7.

Graphic Methods in an Educational Course in Mechanics.

I AM glad to have succeeded in calling forth some correspondence on this subject. But since I have evidently failed to make my views clear, may I briefly restate my contention?

By an educational course in mechanics, I mean a course intended to teach a beginner the principles of mechanics; a course that will leave him properly equipped for more technical work.

By "analytical methods" I mean those methods in which we resolve forces and take moments about axes. Working diagrams and plotted curves (as is quite clearly implied or stated in my former letter) would accompany such work, and would not come under the head of graphic statics.

By "graphic methods" I mean those methods that depend on accurate drawing only, there being no calculation; methods in which "resolution" is replaced by the drawing of force polygons, and "taking moments" by the drawing of funicular polygons.

I advocated the exclusive use of the former methods in bringing the beginner up to the desired point at which there would no longer be danger of confusion of ideas as to principles. Such methods demand the use of simple equations and of a little elementary trigonometry.

Mr. Milne, I see, agrees with me in the main. I cannot, however, agree with him in his view that the employment of analytical methods implies that the teaching is not to be experimental, or leads to impressing on the pupil the idea that "statics is practically useless." Surely he would find "*resolving*" and "*taking moments*" more practical than drawing polygons of forces and funicular polygons in introducing a beginner to the action of machines, to matters of friction, to the nature of bending moments and shearing forces, to the torsion of shafts, and, indeed, to most of the problems of practical mechanics.

Even in the case of "statics of structures," if we limit ourselves (as I do here) to such a range as will be sufficient to make the principles clear, there is much to be said for the analytical "*method of sections*"; and if this be employed there is less temptation to present to the beginner the *un*practical "weightless frame, loaded at the joints only." However, in this branch of mechanics, graphic methods must be employed sooner or later when the learner passes beyond the simpler forms of structures.

Mr. Trotter has quite misunderstood me! He speaks much about (or against?) mathematics; says that my pupils should "emerge as mathematicians"; and refers (deprecatingly?) to "wranglers."

I cannot see that the employment, with beginners, of the methods of *resolution* and *taking moments* would produce a race of wranglers, any more than that the employment of graphic methods would produce a race of geometricians or artists.

Further, he considers me as opposed to the use of diagrams, and as preferring formulæ to explanations given in "quite ordinary language"; and he asks (indignantly?) whether I "would deny the use of a piece of string on a globe to explain great circle sailing?" I may state briefly that I am not a mathematician, that I am fond of diagrams, that I delight in simple language, and that I would give two pieces of string to any pupil who had serious aims in view. I do not think that the above were quite reasonable deductions from my letter.

I do not wish in my turn to misunderstand Mr. Trotter. But I gather from the second paragraph of his letter (vol. lxx. p. 81) that he claims the use of "quite ordinary language" as the prerogative of those teachers who use graphic methods in preference to the analytical methods of "resolution" and "taking moments"? I gather also, from the last paragraph, that, in his opinion, *to resolve forces* and *to take moments about axes* "confuse learners of statics"; and that these analytical methods are a failure when applied to dynamics? Certainly there is here a real difference of opinion between Mr. Trotter and myself.

Devonport, May 28. W. LARDEN.

THE graphic methods are the complement of the analytical, and a mind brought up on either to the exclusion of the other is but half trained. I agree with Mr. Milne that the best results are obtained when the two methods are used side by side. But there is another and potent reason for including graphic methods in an elementary course; they can to a great extent be used at an earlier stage and before the student has proceeded far in his mathematical training. The triangle of forces is practically the only principle involved, and if this is satisfactorily taught, so that in any practical application the student can write out clearly an explanation of his diagram showing what the different lines represent, he will then proceed naturally to the analytical methods of *resolving* and *taking moments*. But he will never abandon the graphic methods, which should now be developed simultaneously with the analytical. His mastery of the two, with the analytical, as I think, resting on the graphic, will give him greater resourcefulness than he would be likely to obtain from an exclusive use of one method.

I want to see the study of mechanics, even in its elementary stages, brought into closer union with practical requirements, and the barrier which usually separates theoretical from applied mechanics to a considerable extent removed. The inclusion of graphic methods tends to prevent the discussion of fantastical problems invented by the mathematician from usurping the consideration of the more practical kinds required by the engineer. In the elementary work it is not usual to take account of the internal forces which are called into play when any solid is in equilibrium under external forces. I think that the stresses induced in a bar of no appreciable weight by forces applied at its extremities should be considered at a very early stage, and then the student may work easy problems on the equilibrium of simple frames. Of course these problems are all more or less idealised, but they will serve to show him that he is at work upon something of practical value, and he will not fail to grasp and appreciate it. W. J. DOBBS.

East Putney, May 27.

The Drumming of the Snipe.

IT is disputed whether the snipe's drumming—a curious noise, suggestive of a miniature threshing machine—is made by the bird with its wings or by its tail, or by both wings and tail. Some recent observations incline me strongly to believe that the tail plays at any rate the more important part. During the performance the bird flies at a great height round and round in a wide sweeping circle. At intervals he makes a sudden and rapid descent, holding his wings partly flexed and his tail spread to its full extent. The outermost tail feather on either side points outward at a greater angle than those adjoining it, so that when the bird is watched through a good field glass daylight shows between it and the next; and, if I am right in my view, the drumming sound is due to the rush of air against this isolated feather. The snipe's tail feathers seem so puny that it is at first difficult to believe that they can produce so great a result. But if an outer one be taken—it is slightly scimitar-shaped with the outer web much reduced—and swung rapidly through the air, the drumming noise may be distinctly heard, though it seems but a very faint echo of the loud throbbing hum that startles one when it suddenly descends from an ethereal height, and the small bird is descried, hardly more than a speck to the naked eye, circling round in wild career, and now and then swooping headlong downwards and thrilling the air with his weird music. F. W. HEADLEY.

Haileybury.

THE PRESENT POSITION OF GEODESY.

THE article by Commandant Bourgeois in the *Revue Générale des Sciences* for April 30, on the present position of geodetic science is both instructive and useful with reference to those problems in geodesy which are just now before the scientific public of this country. There is, in the first place, a notable scheme for the construction of a geodetic arc in Africa which shall extend from the Cape to Cairo. Of this Commandant Bourgeois has taken due note, entering rather fully into the details of such difficulties as its projectors may find in the way of its successful accomplishment. There is also an agitation recently started amongst astronomers and surveyors, which has for its object the revision of the geodetic triangulation of England in order that it may be brought into line, scientifically, with the geodetic triangulation of adjoining countries, and take its place (as it should) as a link in more than one European system of which the value would be largely increased by this extension. Of this Commandant Bourgeois takes no note (probably because he is unaware of its existence), nor does he concern himself with any past achievements in the field of geodesy in which England has borne a part either at home or in India.

The object of the article is to place before the reader the effect of fresh inventions and new methods in developing existing geodetic projects, but it would have added much to the interest of it if so competent an expert as Commandant Bourgeois had written something about the change which has come over the objective of geodetic science which justifies its continued application to modern fields of surveying. These are utilitarian days, and seeing that the science of geodesy long ago evolved all the necessary factors for the reduction of astronomical and terrestrial observations by giving us certain mathematical formulæ based on the measurement and form of the earth, and that no subsequent investigations will ever seriously affect those deductions, it may well be doubted if any State financial assistance would be justifiable for the mere purpose of refining and polishing the results of what would be a purely abstract scientific inquiry. Geodetic arcs measured simply for the purpose of ascertaining the nature of certain eccentricities in the figure of the globe will no longer be regarded as worthy of the saving grace of State financial support, and it will remain for their projectors to prove that some other and more practical end is to be served by them if they wish for substantial recognition.

There is, of course, another (and an insufficiently appreciated) end to be served by such exact scientific processes as are involved in the measurement of a "great arc"; and if we drop the somewhat misleading term "geodetic," and simply appeal to the absolute necessity for a strong initial backbone of first-class triangulation as the basis of every survey scheme of any consequence at all—a backbone which will support the weight of any subsequent superstructure of looser and more rapid forms of triangulation which may be built upon it, and thus give solidity and homogeneity to the whole mapping of a vast area (such as Africa, for instance), we only indicate the same thing under a far more practical and intelligible form. All surveyors are agreed as to the necessity for such an initial backbone, although perhaps opinions may differ as to how far it should be extended. The great value of Commandant Bourgeois's article lies in this—that he shows clearly and concisely how the best possible scientific results may be obtained by means which not long ago were unattainable, and which involve half the expense, with (possibly) double the accuracy of those older methods which cost the country so much in the past, and (in the case of England, at least) have not proved satisfactory in the end.

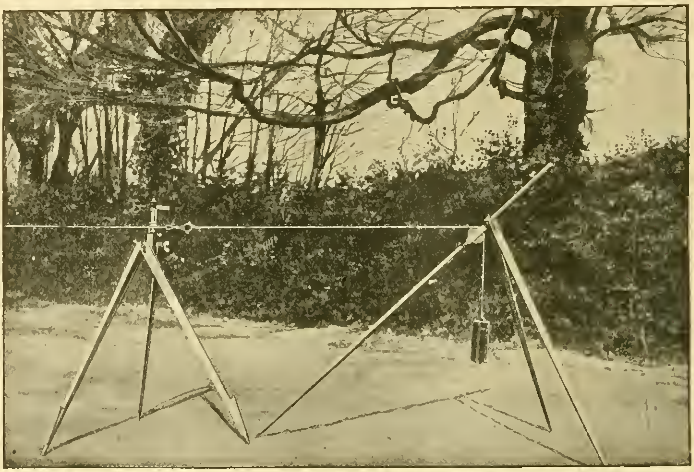


Fig. 1.—Jaderin apparatus placed in position for base measurement.

The Jäderin apparatus for base measurements, and the application of the French metal "invar" (an amalgam of 64 steel to 36 nickel) to it, is perhaps the most important of all recent improvements in the process of constructing a primary, or "first-class," triangulation. The old, clumsy, and inconvenient method of measurement by compensation bars has, we hope, disappeared for ever. The Jäderin tape has been exhaustively tested under other conditions than those mentioned by Commandant Bourgeois, and it has been found to stand the test of extremes of climate quite sufficiently well. The author indeed advocates its use for the measurement of long bases in supersession of the system of extension by triangulation from a short one. The rapidity and accuracy with which this method can be applied to the base measurements connected with a long series of principal triangulation is instanced in the case of the North American meridional arc, which has been measured on the 98th degree of west longitude. In this instance nine bases were measured in one field-season

lasting six months. Five tapes were made use of, all five being tested over one kilometre of distance to determine their relative equations. These may be expressed by 1/690,000 maximum and 1/1,200,000 minimum of probable error. Altogether more than 69 kilometres of base measurement were effected at a cost of 160 dollars per kilo. Commandant Bourgeois maintains that the limits of probable error in linear measurement are in satisfactory relation to the limits of probable error in the angular measurements of the instrument used for triangulation. But he does not fully describe the latter. One of the essential features in modern principal triangulation is the employment of instruments of half the size and about one quarter the weight of those which were deemed necessary twenty-five years ago. Improvements in graduation and, above all, the introduction of the micrometer eye-piece have so far added to the accuracy of modern theodolites that a 12-inch instrument in India now takes the place of the 24-inch

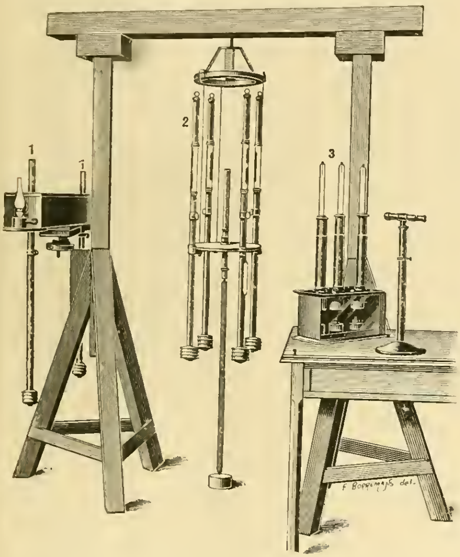


FIG. 2.—Apparatus of M. Hecker for measuring the intensity of gravity in the open sea by comparison of the readings of the barometer (1 and 2) and hypsometer (3).

and 36-inch instruments formerly used. Surveyors will probably have their own opinions as to the methods of observation indicated by Commandant Bourgeois. The German method approved by him, and adopted in France, appears to contemplate certain irregularities in the signals for observation which ought not to exist. It will probably be found that the system of observing should be adapted to the atmospheric peculiarities of the district in which the observations are taken. But the German method is well worth the careful attention of English surveyors.

That part of the article which deals with the deflection of the plumb line and the intensity of the force of gravity, has a most interesting reference to M. Hecker's apparatus for investigating these problems in ocean spaces by means of a comparison between barometric and hypsometric observations; the general result of such observations taken in the Atlantic between Bahia and Lisbon being to prove that there is no great variation between the results determined in the deep sea and on the Continent. M. Hecker is still engaged in this branch of geodetic inquiry.

The reference to the African are now contemplated, and to an equatorial arc recently measured by French scientists in the Republic of Equador in South America, should be studied together, for the experience obtained in the latter points some useful morals for the consideration of those who may undertake the measurement of the former. The physical conditions of the country and the variations of an unusually tempestuous season presented but small obstruction to the progress of the work compared to the hostility of the indigenous Indians. Stations were destroyed and markstones uprooted with such persistent animosity in Equador that a great part of the observations had to be repeated. If principal, or geodetic, triangulation is to serve the purpose of scientific investigation only, the destruction of the observing stations would not be of so much consequence, when once the chain of triangles composing the arc was finally complete. But it is obvious that if any useful ulterior purpose of map-making is to be served by the expensive process of laying down a backbone of well-fixed points, it is all important that every station and every markstone should be preserved with the utmost care. In spite of most elaborate precautions these most necessary indications are sometimes lost in India, and fresh observations have to be made in order to redetermine their position. Isolation of the instrument during the process of observing is almost always imperative, although it occasionally happens that a considerable area of hard rock exists of sufficient stability to serve as the basis of the observing station without involving any artificial isolation. But the building of isolating pillars and the erection of cairns over them for protection almost inevitably attracts the attention of the tribespeople in the neighbourhood, and the result is subsequent destruction.

The only way to safeguard with any prospect of success against the utter waste of time and money which is involved by the destruction of signals and markstones, after the triangulation has been effected with scientific precision and rigorous methods of observation, is to fix, *pari passu* with the principal triangulation, a large number of secondary points scattered over the face of the country, consisting of natural features which it is impossible to remove, or for Indians to identify. It cannot but happen that principal triangulation carried through an arc of 65° of amplitude in such a country as Africa will involve a great deal of native hostility, and its preservation finally will be almost an impossibility. It will be most necessary, therefore, to take all classes of observations that have eventually to be taken from any one station at one and the same time of occupation. It may indeed be an open question whether one or two short principal series from the coast westward, following, say, the Zambesi and the Uganda Railway to the meridian of 30° E., would not sufficiently answer the utilitarian purposes of a basis for African surveys were they connected by secondary or even tertiary triangulation at their extremities, and the connection pushed northward to meet a third principal series on the Nile. This, however, is but a side issue prompted by the perusal of the admirable article in the *Revue Générale des Sciences*.

One especially interesting result of the observations for level deflection taken in connection with the Equador arc, is an indication that the compensation of exterior mass by interior deficiency, or want of density, indicated by such observations at certain Himalayan stations, does not exist in the equatorial region of the Andes. T. H. H.

THE INTERNATIONAL ASSOCIATION OF ACADEMIES.

THE delegates of the International Association of Academies met at the Royal Society on Wednesday, May 25, and Sir Michael Foster, K.C.B., was elected president of the general assembly. A number of resolutions were adopted at that and other business meetings, and are incorporated in the official report of the proceedings, but this has not yet reached us.

The delegates were received by the King at Windsor on May 25, and attended a conversazione at the University of London on May 27. Throughout the evening many objects of scientific interest were on view, but, with a few exceptions, the exhibits were the same as those shown at the recent conversazione of the Royal Society, and already described (May 19, p. 70). Among the additional exhibits were the following:—Horse face-pieces and other ornaments from the trappings of cart-horses, Miss L. Eckenstein; prehistoric Egyptian stone vases, Mr. Randolph Berens; (1) Japanese paintings (Kakemono), (2) photomicrographs of iron and steel, Prof. W. Gowland; series of Egyptian beads, Prof. W. M. Flinders Petrie, F.R.S.; mimetic resemblance of the different forms of a single species to two or three different models, Prof. E. B. Poulton, F.R.S.; seed-bearing plants from the Coal-measures, Mr. E. A. Newell Arber, Miss M. Benson, Mr. R. Kidston, F.R.S., Prof. F. W. Oliver, and Dr. D. H. Scott, F.R.S.; paradoxical shadows in a non-homocentric beam of light, Prof. Silvanus P. Thompson, F.R.S.; freshwater phytoplankton from various parts of England and Ceylon, Dr. F. E. Fritsch; series of rubbings of brasses, Hilda Flinders Petrie; stone implements and model of raft from the lowlands of eastern Bolivia, Dr. J. W. Evans; (1) model of steam ship *Turbinia*, (2) (*a*) 4 kilowatt turbine-driven dynamo, (*b*) model of 4000 kilowatt turbine-driven alternator, (3) turbo-blowing engines, the Parsons Marine Steam Turbine Company, Limited.

On Saturday the foreign delegates visited Oxford and Cambridge in two parties, and the honorary degrees referred to elsewhere (p. 115) were conferred by the universities. A complimentary banquet to the delegates was given at the Mansion House on Monday by the Lord Mayor of London.

ROBERT McLACHLAN, F.R.S.

THE death of Robert McLachlan, familiarly known to his friends as "Mac," removes from our midst one of the most prominent characters in the London entomological world during the last half-century. He joined the Entomological Society as long ago as 1858, and always interested himself greatly in its welfare, having successively filled the offices of secretary and president, and still holding (as he had done for many years past) the office of treasurer at the time of his death. Till the last few months, when failing health compelled his absence, he was most regular in his attendance at the meetings. He was also one of the five original founders of the *Entomologists' Monthly Magazine* (in 1864), and up to the last was still one of the acting editors—the last of the founders—the other four having all died or retired many years ago.

Mr. McLachlan was the son of a ship's-chandler on Tower Hill, whose instruments were very highly esteemed by the mercantile community. Being possessed of independent means, he devoted his life to entomology, though, as a child, he tells us, in some autobiographical notes in his Presidential Address to the Entomological Society, in January, 1887, he had taken most interest in botany. He made one voyage to the Southern Seas in 1855, and finally settled himself at Lewisham, near his intimate friend Stainton, occasionally visiting various parts of the British Isles, and the Continent of Europe; especially when any entomological congresses were on foot, which he was very fond of attending. Like most of his contemporaries, Mr. McLachlan commenced his entomological studies with British Lepidoptera, as we learn from the list of entomologists in the *Entomologists' Annual* for 1858, where his name first appears, at which time he was living at Forest Hill; but he soon turned his attention to Neuroptera, the study of which order in England received a great impetus just then by Dr. Hagen's papers in successive *Annuals*. McLachlan especially attached himself to the Trichoptera, or caddis-flies, which he studied largely from an anatomical standpoint, often, in later years, speaking contemptuously of coloured figures of butterflies as being only fit for children. He contributed many important papers on British and foreign Neuroptera and Trichoptera to entomological journals, and being in constant communication with the leading neuropticists at home and abroad, was able to bring together one of the finest collections in the world in his special groups, part of which, at least we hope, will find a permanent home at the Natural History Museum, South Kensington. Part of the national collections of Neuroptera, previously catalogued by Walker, were rearranged and annotated by McLachlan. He compiled (with the exception of the Ephemeridæ, which were undertaken by the Rev. A. E. Eaton) the catalogue of British Neuroptera published by the Entomological Society of London in 1870, and he also compiled the reports on Neuroptera and Orthoptera for the *Zoological Record* from 1869 to 1885. His most important scientific work was his "Monographic Revision and Synopsis of the Trichoptera of the European Fauna" (1874–1884), but his smaller publications are extremely numerous. Mr. McLachlan was never married. He died at his residence at Lewisham at the age of sixty-seven, on May 23, to the regret of a wide circle of entomological friends and acquaintances. W. F. K.

ÉMILE SARRAU.

THE great advance in modern artillery and ballistics is due principally to the efforts of the French Government, determined not to be caught a second time at a military disadvantage. The progress has been made in the most rapid and economical manner by the appointment of committees, composed of experts chosen for their exact scientific knowledge, such as Sebert, Berthelot, Vieille, to investigate the problem and to solve the details by a judicious combination of theory and experiment.

Chief among these scientific experts, Sarrau was also the director of the Government factories of modern explosives, and at the same time professor of the theory at the École Polytechnique in Paris, and the School of Application at Fontainebleau.

We can follow the general course of his lectures by his published books on the theory of explosives; these will emphasise the lead taken by the French, and their contempt for any secretiveness about the laws of nature involved in the corresponding phenomena.

His books and other practical achievements serve to show his success in design and invention; at the same time the obituary notices by his colleagues tell us how highly he was appreciated and esteemed as a teacher by his classes of pupils.

NOTES.

THE annual visitation of the Royal Observatory, Greenwich, will be held on Saturday next, June 4.

THE following have been elected honorary and foreign members of the Chemical Society:—Prof. A. H. Becquerel, Prof. C. A. L. de Bruyn, Prof. F. W. Clarke, Madame Curie, Prof. C. T. Liebermann and Prof. E. W. Morley.

A DEPUTATION from the Yorkshire Philosophical Society will wait upon the York City Council on June 6 with the object of asking the corporation to issue an invitation to the British Association to make York the meeting place in 1906.

THE death is announced of M. Charles Soret, formerly rector of the University of Geneva, and a member of council of the French Physical Society.

THE Lombardy *Rendiconti* announces the death of Prof. Amato Amati, one of the most energetic educationists in Italy, and the author of works on Dante and on geography.

THE death is announced of M. E. D. del Castillo, who prepared a flora of the French islands of Polynesia and described a portion of the plants brought from Madagascar by M. Alfred Grandidier.

AT a meeting of the General Medical Council on Tuesday, the following resolution was passed:—"That the president (with the chairman of the Pharmacopœia Committee) be requested to inform the Lord President of the Privy Council that in the opinion of the council it is desirable that after a sufficient period, to be fixed by law, the metric system of weights and measures should become the one legal system for the preparation and dispensing of drugs and medicines; that the council would view with favour the passing into law of a Bill such as that now before Parliament entitled the 'Weights and Measures (Metric System) Bill'; and that in that event the council would be prepared to take all necessary steps to give effect to the law by making the proper modifications in the 'British Pharmacopœia.'"

A REUTER message from Wellington, New Zealand, reports that the King has sent the following telegram to Captain Scott, leader of the National Antarctic Expedition:—"I have read with interest your report, which Sir Clements Markham sent me. I congratulate you and your gallant crew on your splendid achievements, and wish the *Discovery* a safe journey home. I hope to see you on your return to England."

IN a letter to the secretary of the Scottish Antarctic Expedition, says the *Times*, Mr. W. S. Bruce, the leader of the expedition, remarks:—"We have reached the south-eastern extremity of the Weddell Sea, discovering there a great barrier of ice, part of the Antarctic Continent. We have gone 215 miles further south than last year, and 180 further than Ross in this part of the Antarctic regions. We got beset here in 74° S., 23° W., and were frozen in for a week, from the 7th to the 12th of March. When we got out by chance I thought it wisest not to proceed further in trying to get south and west, but to continue our programme to the north-east. We have sounded in depths up to 2900 fathoms and trawled in depths of 2660 fathoms (where Ross marks 4000 fathoms, no bottom)."

A REUTER message from Rome reports that the Marconi wireless telegraph stations at Bari and Antivari (Montenegro) have now been erected for some time, and are in regular working order. The high power station at Coltano (Pisa), near the Royal farm of San Rossore, will be the largest in the world, and will be built entirely of stone. It will be ready in August or September, after which the engines and other apparatus will be installed, so that it may begin working not later than the beginning of 1905. The Coltano station will be able to communicate with Great Britain, Canada, the United States, and the Netherlands, as well as with all vessels in the Mediterranean, the Baltic, the Red Sea, the Atlantic Ocean, and the Indian Ocean.

THE eighty-seventh annual meeting of the Société helvétique des Sciences naturelles will be held at Winterhour from July 30 to August 2. The business of the association will be transacted in seven sections as follows:—mineralogy and geology, botany, zoology, chemistry, physics and mathematics, medicine, and civil engineering. The annual meetings of the Swiss societies of geology, botany, zoology, chemistry and of the Société zurichoise de Physique will be held at Winterhour at the same time. The president of the association will be Prof. J. Weber, the vice-president Prof. E. Lüdin, and the secretary M. E. Zwingli, to whom all communications should be addressed at Geiselweidstrasse, Winterhour.

IN recent numbers of NATURE (March 24 and April 21) Prof. Nagaoka and Prof. Franklin have described methods for demonstrating the change of length of iron wire by magnetisation. Prof. J. C. McLennan, University of Toronto, writes to say that a simple and satisfactory method of exhibiting this phenomenon is described in the *Physical Review*, vol. iv., No. 35, July, 1898, and consists in the use of an optical lever attached to the test specimen.

MR. T. TERADA writes to us from the College of Science, Tokyo, to direct attention to an optical illusion observed when lycopodium powder strewn on the surface of water is made to gyrate by a jet of air. After the whirling powder has been fixedly regarded for some time, and the eyes are directed to an adjoining table, the surface of the table appears to move in a direction contrary to that of the lycopodium.

DR. D. PACINI sends us from Rome an account of careful experiments made by him with the object of observing the effects of *n*-rays described by M. Blondlot and other investigators. Though his observations were made under very favourable conditions, he was unable to detect any increase of luminosity of a phosphorescent screen caused by unknown rays from strained or tempered steel, an Auer lamp, a Nernst lamp, sound vibrations, or a magnetic field, though various French observers have affirmed that in each of these cases *n*-rays are emitted which produce an effect upon the screen.

IN the course of an interview reported in the *Westminster Gazette* of Friday last, Lord Kelvin is reported to have expressed himself as being decidedly of the opinion that the source of energy of the heat emitted by radium is not in the element itself. He remarked:—"It seems to me absolutely certain that if emission of heat at the rate of 90 calories per gram per hour found by Curie at ordinary temperature, or even at the lower rate of 38 found by Dewar and Curie from a specimen of radium at the temperature of liquid oxygen, can go on month after month, energy must somehow be supplied from without."

A PAPER on crystalline glazes and their application to the decoration of pottery, read before the Society of Arts by Mr. William Burton, and printed in the current number (May 27) of the *Journal* of the society, is a noteworthy contribution both to the science and the art of pottery. By applying scientific knowledge and method to the production

of glazes on pottery, Mr. Burton has been able to obtain with precision a variety of crystalline and opalescent effects of decided novelty and beauty. This has only been rendered possible by making many experiments to discover the influence of the materials and the temperature on the effects produced and by having each stage of the process under perfect control. In one of the new glazes produced in this way, artificial crystals which are developed in full perfection at temperatures from 1000° C. to 1030° C. are reabsorbed into the glaze as the temperature is increased, and remarkable changes of colour are assumed until at a temperature of 1070° C. the crystals are entirely reabsorbed. The crystalline effects produced at the different temperatures are of interest to the mineralogist, and the striking appearance of the pottery upon which the crystals are developed demonstrates the advantages of the application of science to industrial art.

THE first excursion of the summer session of the Belfast Naturalists' Field Club was held on May 21, when 167 members and their friends visited Hillsborough to explore and examine the demesne of the Marquis of Downshire. Though this is the largest attendance at any one of the meetings of the society, the Belfast Naturalists' Field Club is, in the forty-second year of its existence, one of the most active Irish societies devoted to the practical study of natural history. The main object of the club is to interest people generally in the study of natural objects, and this is, of course, all that can be accomplished in gatherings of the size mentioned. We are glad to know, however, that many of the members have been able, by private additional visits, to add to the scientific knowledge of the district. The honorary secretaries of the club are Mr. Nevin H. Foster, Hillsborough, co. Down, and Mr. James Orr, 17 Garfield Street, Belfast.

THE *Zeitschrift der Gesellschaft für Erdkunde* contains an extremely interesting report of a lecture on western Asia Minor by Dr. A. Philippson. Having completed his work in Greece, Dr. Philippson has undertaken the investigation of this little known region, which is of special interest to Germany on account of the Anatolian Railway. His paper summarises the results of explorations up to the present time.

UNDER the title "A Case of Geographic Influence upon Human Affairs," Mr. George D. Hubbard discusses the results of glaciation in a limited portion of the State of Illinois in the *Bulletin* of the American Geographical Society. The subject is dealt with "from the point of view of geographic influence upon plants, crops, and animals, and upon man's distribution, occupations, successes, and failures," and the paper is a good illustration of the method of treating the geological element in questions of the kind.

IN an article on the developmental changes in some common Devonian brachiopods (*Amer. Journ. Science*, April), Mr. Percy E. Raymond describes, from abundant material, the life-changes undergone in a number of species of brachiopods, with especial reference to the character of the nepionic shell, the development of the pedicle tube and the deltidial plates, and the acquirement of surface characters. The specimens were obtained from the Moscow (Hamilton) shales, near Canandaigua Lake, New York. They occurred in layers of impure limestone, but were completely replaced by silica, and when the rock was etched in acid the fossils were left in a remarkably perfect condition. The fauna comprised many forms of invertebrates, besides brachiopods, and included many individuals in immature stages.

A RESTORATION of the Ornithosaurian Pteranodon has been prepared by Mr. G. F. Eaton, as the contribution of the Department of Vertebrate Palæontology of the Yale Museum to the St. Louis Exhibition. Particulars, accompanied by a half-tone engraving (which we are enabled to reproduce), have been published in the *American Journal of Science* (April). The genus was originally described by Marsh from the Cretaceous rocks of North America, but further details of its structure have since been obtained. Mr. Eaton points out that the sclerotic circle is composed of twelve thin plates of bone arranged with overlapping edges, so as to form a hollow truncate cone, similar in shape to the avian sclerotic circle. With regard to the vertebræ, there are nine cervicals. In the dorsal series are included eight vertebræ, anchylosed to form the notarium, and four free dorsals intervening between the notarium and the sacrum. By assuming that the first four vertebræ of the sacral series (in the broader sense) are homologues of the lumbars of other groups, the total number of presacral vertebræ would appear to be twenty-five. This compares closely with the supposed number of presacrals in the Eusuchia.

FIG. 1.—Restoration of *Pteranodon longiceps*, Marsh. Scale an inch to about 3 feet.

IN the second part of vol. xxxvi. of the *Memoirs* of the Russian Geographical Society, for general geography, Prof. N. Zarudnyi gives the second part of the account of his journey to eastern Persia. It contains a description of the 421 species of birds found by him, with the addition of a few species previously observed by Dr. Blanford and Dr. Aitchison. It would be premature as yet to draw any general conclusions concerning the relations between the avifauna of eastern Persia and the other parts of the Iran plateau and the Turan lowlands. Consequently, the Russian ornithologist only gives a description of each species, with interesting notes concerning the habits of the species and its distribution. Dividing his region into six districts, he gives the lists of nesting and temporary visiting birds for each district separately.

THE larval eyes of the mollusc Chiton and their ultimate fate form the subject of an article by Mr. H. Heath in the March issue of the *Proceedings* of the Philadelphia Academy.

In a recent issue (vol. lxxii., No. 3) of the *Journal* of the Asiatic Society of Bengal, Mr. E. P. Stebbing records the occurrence in the Himalaya of a beetle of the genus Thanasimus, a discovery which may be of some commercial importance, owing to the fact that these insects feed on the bark-beetles so destructive to timber.

A feature in the report of the proceedings of the sixteenth annual meeting of the U.S. Association of Economic Entomologists (Ent. Divis. Agric. Dept., *Bull.* No. 46), is an address on insect photography by Mr. M. V. Slingerland. While urging the importance of this comparatively new application of photography, the author points out that many of the replicas of photographs published in current literature are of a very inferior type.

In the May number of the *Zoologist* the editor continues his notes on the influence of rivers on animal distribution, dealing, first, with their active, and, secondly, with their passive effect as dispersers. A very large number of cases are cited where animals—singly or in parties—have been involuntarily carried down by rivers, while in the second part the author has been equally industrious in collecting records of instances where animals have swum rivers of considerable breadth.

Invertebrates form the subject of the four articles in the latest issue (vol. lxxvi., part iv.) of the *Zeitschrift für wissenschaftliche Zoologie*. Messrs. Schuberg and Schröder describe a new thread-worm infesting the muscles of leaches of the genus Nephelis. The spermatogenesis of sponges and cœlenterates is discussed by Mr. W. Görich, while Mr. C. Julin gives the result of his investigations into the phylogeny of tunicates, and Dr. H. Simroth describes a remarkable new slug, *Ostracolethe fruhstorferi*, from Tonquin, and its bearing on the classification of gastropods.

According to the classification generally in use in this country, fishes are divided into the four subclasses Elasmobranchii, Holocephali, Dipnoi and Teleostomi, while the Palæozoic Ostracodermi (Pteraspis, Cephalaspis, Pterichthys, &c.) are placed in a class by themselves. Mr. C. T. Regan, of the British Museum, in a paper on the phylogeny of the Teleostomi, published in the May number of the *Annals and Magazine of Natural History*, has, however, arrived at the conclusion that a much simpler scheme is advisable, and that it will suffice to divide the class (inclusive of the Ostracodermi) into the two groups Chondropterygii and Teleostomi, the former including the Elasmobranchii and Holocephali, together with Pteraspis and its allies, and the latter all the rest. The most primitive group of Teleostomi is considered to be the Chondrostei (sturgeons and Palæoniscidæ), from which all the others are derived. One branch gave rise to the Crossopterygii, from which in turn sprang the Dipnoi (Dipneusti), the author regarding the resemblance which has long been known to exist between the fins of the two latter groups as over-riding the differences in the skull-structure. The Teleostei take origin as a separate branch from the Chondropterygii. The most pronounced departure from the views of others is, however, the brigading of the Ostracodermi (exclusive of Pteraspis, which is regarded as a chondropterygian) with the Arthrodira (Coccosteus, &c., generally grouped in the Dipnoi), as an offshoot of the Crossopterygii, under the title of Placodermi. Mr. Regan will, we think, have considerable difficulty in persuading palæontologists to accept this part, at any rate, of his scheme.

It is stated in *La Nature* (May 28) that Dr. Chaput has found that peroxide of zinc (discovered by Elvas) proves an efficient substitute for peroxide of hydrogen for dermatological and other uses, and is much less irritating than the last named substance.

The April issue of the *Journal of Hygiene* (vol. iv., No. 2) contains a number of most interesting and important contributions. Staff Surgeon Dalton, R.N., and Dr. Eyre have investigated the thermal death point of the *Micrococcus meletensis*, which proves to be 57°·5 C. They describe an apparatus whereby constant temperatures may be maintained, and suggest standard conditions for the determination of the thermal death points of micro-organisms. Dr. Houston, in a paper on the bacteriological examination of oysters and estuarial waters, details the main facts obtained during an investigation undertaken on behalf of the Royal Commission on Sewage Disposal. Dr. Nuttall and Mr. Inchley describe an improved method for measuring the amount of precipitum in connection with tests with precipitating antisera. Dr. Stevenson suggests a method of estimating future populations. Messrs. Bowhill and Le Doux give a note on a case of piroplasmosis canis, a tick disease of the dog, occurring near Grahamstown, and Dr. Nuttall describes the disease in a lengthy article illustrated with photos and temperature charts. Lastly, Dr. Graham Smith describes very fully a study of diphtheria bacilli isolated from 113 individuals during an outbreak of diphtheria at Cambridge in 1903.

The fifth volume (second series) of the *Publications* of the U.S.A. Naval Observatory is devoted to a complete record of the meteorological observations made at the new Naval Observatory, Georgetown Heights, during the years 1893–1902 inclusive. After a preliminary description of each of the instruments used, the readings of the barometer and the wet and dry bulb thermometers, and the cloud and wind observations at three-hourly intervals during each day are given. The whole of the results are summarised in an exhaustive series of tables which conclude the volume.

In the *Annals of Botany* for January, Mr. Harold Wager discusses the function of the nucleolus in plants and animals, and, basing his deductions upon the investigation of the nucleus in the cells of the root-apex of Phaseolus, he comes to the conclusion that the nucleolus is intimately bound up with the formation of the chromosomes, and that there is a definite continuity of nuclear substance from mother-nucleus to daughter-nucleus through the chromosomes. Mr. Wager has also attacked the problem of the cell structure in the Cyanophyceæ, and in a preliminary paper communicated to the Royal Society he claims that the central body of the Cyanophyceæ is a nucleus of a simple or rudimentary type.

The second volume of the second revised and enlarged edition of Prof. W. Pfeffer's work on "Pflanzenphysiologie" (Leipzig: Engelmann; London: Williams and Norgate) has been received. The volume is chiefly concerned with transformations of energy resulting in various movements in plants.

Three pamphlets on radium and radio-activity have just been received from German publishers. One is a second edition of a useful summary, by Prof. K. Hofmann, of investigations of Becquerel and other rays from 1896 to the present time; the title is "Die radioaktiven Stoffe nach dem neuesten Stande der wissenschaftlichen Erkenntnis" (Leipzig: Barth). The same publisher has

issued a translation, by Prof. G. Siebert, of Mr. F. Soddy's Wilde lecture (see Nature, March 3, p. 418) on the evolution of matter as revealed by the radio-active elements. A translation, by Mr. E. Ruhmer, of a lecture by Mr. W. J. Hammer, delivered before the American Institute of Electrical Engineers, on radium and other radio-active substances, has been issued by the publishers of *Der Mechaniker*, Berlin.

OUR ASTRONOMICAL COLUMN.

The Extreme Ultra-Violet Spectrum of Hydrogen.—In No. 4, vol. xix., of the *Astrophysical Journal*, Mr. Theodore Lyman, of Harvard University, gives a list of wave-lengths for the lines in the extreme ultra-violet spectrum of hydrogen, first discovered by Dr. Victor Schumann. In Mr. Lyman's experiments the light from the discharge tube was transmitted through fluorite windows and a tube containing hydrogen at very low pressure, and the spectrum was formed by a concave grating ruled on speculum metal. He found that from the region about λ 1854 to about λ 1700 the spectrum is almost continuous, containing only a few faint lines. About λ 1700 there is an absorption band, the width of which seems to depend upon the purity of the hydrogen enclosed in the apparatus. Beyond λ 1650, towards the more refrangible limit of the spectrum, numerous fine lines exist, and of these Mr. Lyman has measured 134. In the table accompanying the paper the wave-lengths (to five figures) and intensities of 133 lines between λ 1033 and λ 1878 are given. It is interesting to note that the superior reflecting power of speculum metal for these short wave-lengths has been incidentally demonstrated by the use of the grating.

Variable Radial Velocity of η Piscium.—A series of spectrograms of η Piscium obtained by Prof. H. C. Lord, of Columbus (Ohio), and extending over the period December, 1901, to January, 1904, indicate that this star has a variable radial velocity of long period.

From measurements of Hγ and thirteen carefully selected iron lines the following results, among others, were obtained :—

Date	Radial vel. (Reduced to Sun)	Date	Radial vel. (Reduced to Sun)
Dec. 15, 1901 ...	+18·5 kms.	Dec. 15, 1903 ...	+ 9·5 kms.
Jan. 10, 1902 ...	+25·4 ,,	Jan. 9, 1904 ...	+10·6 ,,

The sharp definition of the lines in the spectrum of η Piscium render its radial velocity especially suitable for spectroscopic measurement, and this fact, with other confirmatory evidence, leads Prof. Lord to the conclusion that the variability is real (*Astrophysical Journal*, No. 4, vol. xix.).

Proposed New Observatories.—In a report published by the Carnegie Institution at Washington (December, 1903), a committee consisting of Profs. Boss, Campbell and Hale, which was appointed by that institution "to consider certain large projects in astronomy," strongly urge the establishment of an observing station in the southern hemisphere for the prosecution of certain definite observations which it is hoped might be completed in ten or twelve years. They also recommend that an observing station for solar investigations in an exceptionally favourable atmosphere should be established and maintained throughout one full sun-spot period (eleven years) at least. Further, they urge the construction and maintenance of a large reflector for astrophysical investigations at one, or both, of the proposed stations. These recommendations are supplemented by a detailed programme of the work that might be accomplished and a carefully prepared scheme for the necessary buildings and staffs.

In Appendix A Prof. J. W. Hussey, who was deputed to explore California and Arizona in order to determine the most suitable site for the proposed solar observatory, gives an interesting account of his search, which led to the recommendation of Mount Wilson (California) as offering the best facilities for the work. Appendix B consists of a number of letters from eminent astronomers in answer to a confidential inquiry as to their views on the establishment of the proposed observatories.

Variability of Spark Spectra.—Some interesting results have been obtained by Mr. A. S. King, of Bonn, from a long series of experiments on the variability of spark spectra with various conditions of current, discharge and environment. So far, the spark spectra of six metals, Cd, Zn, Mg, Ca, Hg and Al, have been studied under different conditions, and the results of the experiments have led to the following conclusions :—

(1) The lines of each metal may be divided into two groups according to their behaviour when the conditions are varied. The first group contains all the "series" lines and a few others, whilst the second group includes the lines for which no "series" relations have yet been discovered. (2) The lines of both groups are enhanced by capacity and weakened by self-induction, but those of the second group are much more affected in this way than those of the first. (3) Of the two "subseries" of each metal the first is much more sensitive to all changes. (4) The last members of a series are reduced more by self-induction than the first, a shift of maximum intensity towards the greater wave-lengths being produced. "Capacity" has the opposite effect.

Mr. King describes his experiments, and discusses the results in detail in a paper published in No. 4, vol. xix., of the *Astrophysical Journal*, where some of his photographs are reproduced.

Report of the Oxford University Observatory.—In the twenty-ninth annual report of the Oxford University Observatory, Prof. H. H. Turner gives a *résumé* of the work accomplished during the twelve months from May 1, 1903, to April 30, 1904. He again refers to the urgent need for a residence attached to the observatory, but on account of the general lack of funds at the university he does not press the matter.

The measurement and reduction of the plates for the Oxford section of the International Astrographic Chart is now complete, and the press copy of the work has been lodged at the Bodleian Library for safety until it is possible to raise the 2000*l*. necessary for its printing and publication. It was proposed that the experience gained by the observatory staff in the production of this work might be utilised in measuring the plates taken at one of the southern observatories where the lack of funds and instruments prohibits the completion of the work. To this end fifty plates were received from the Perth (W. Australia) Observatory, and on measuring twenty-one of them it was found that their reduction could be easily and economically carried out at Oxford.

A stereo-comparator, which is essentially an elaborate and improved stereoscope for the comparison of the star-places on any two plates of the same region, but taken at different epochs, has been presented to the observatory by Mr. C. L. Brook, and has been proved to be efficient and easily manipulated.

The Stereo-Comparator. In No. 5, vol. xii., of *Popular Astronomy*, there appears a translation of a paper communicated to the Astronomical Society of Belgium by Dr. G. van Biesbroeck, in which the author traces the evolution of, and describes, the stereo-comparator invented by Dr. Pulfrich; he also gives brief accounts of the researches wherein the instrument will prove to be an extremely useful aid. Amongst the latter he notices the study of cometary features, the detection of stellar proper motions, and the discovery of minor planets. As evidence of the comparator's efficacy in the last named field, he mentions that Dr. Pulfrich, who was totally without experience in minor planet work, not only found several asteroids which Prof. Wolf had recognised on a pair of plates taken at Heidelberg, but also discovered a new one, which the careful scrutiny of the latter observer, under the ordinary conditions, had failed to reveal.

EMERGENCE AND SUBMERGENCE OF LAND.

At the recent anniversary of the Geological Society, when the president was unable from illness to be present, his place was taken by Sir Archibald Geikie, who prepared an address for the occasion on the evidence supplied by the British Isles as to the problem of the causes of changes in the relative levels of sea and land. This address appears in full in the *Quarterly Journal* of the society, and we here reproduce it in abstract.

(i.) *Emergence.*—Geologists in the British Isles have long indulged the confident belief that Raised Beaches afford demonstrative proof of changes in the relative levels of sea and land. The abundant and striking examples of them around our coasts have been universally accepted among us as marking former sea-margins, whether the sea be supposed to have risen upon the land or the land to have been upheaved above the sea. The recurrence of precisely similar terraces along the western coast of Norway, but on a still more impressive scale, has been regarded as furnishing evidence of an extensive emergence of land, from the south of Britain to the northern end of the Scandinavian peninsula. Prof. Suess, however, seeks to show that, at least as regards the north-western coast of Norway, these opinions are based upon a misreading of the evidence. After his visit to that region, and his study of the literature of the strand-lines, there so wonderfully developed, he has come to the conclusion that the Norwegian fjords furnish no argument against his doctrine that there has been no recent upheaval of the land. He asserts that "we must interpret all the *seter* [rock-shelves] and the great majority of the terraces in the fjords of Western Norway as proofs of the retreat of the ice that once covered so much of the peninsula, and not as proofs of any oscillations of the surface of the sea, still less of any movement of the solid land." It would widen the inquiry too much to enter upon an examination of the evidence as it is presented in Scandinavia. But the author of the address, having been all his life familiar with the strand-lines of this country, and having traced those of the Norwegian coast from Bergen to Hammerfest, directed attention to one or two of the insuperable difficulties with which Prof. Suess's theoretical explanation seemed to him to be beset. The great Austrian geologist appears to have unwittingly confounded two sets of beach-lines, which differ a good deal from each other in general character, and are entirely distinct in origin. Availing himself of the remarkably full and interesting researches of Scandinavian geologists regarding the glaciation of their country, he dwells upon the importance of the terraces left by the fresh-water lakes that were dammed back by the great ice-sheet as it retired. He believes that these phenomena extended even to the Norwegian coast, and that the strand-lines of the fjords, whether in the form of platforms eroded out of the solid rock (seter) or terraces of sediment, mark former levels of lakes that filled these valleys when their mouths were blocked up with the ice-sheet. As the lowest of these strand-lines includes sands and gravels crowded with marine shells, he is compelled to admit that it marks a former sea-beach. But he endeavours to discriminate between it and the other horizontal shelves, which follow it in parallel lines at higher levels. He affirms that the latter present a series of "characters absolutely irreconcilable with what we know of the action of the sea along a shore"—such as the series of fragmentary terraces found at increasing heights inland, their absence from the parts near the general coast-line, and the breadth of the seter. He passes lightly over the fact that some of these higher terraces have yielded marine organisms which are progressively of more Arctic character, according to their altitude, and according, consequently, to the antiquity of the sediments in which they lie.

Now, according to the experience of those northern geologists who have specially studied Scandinavian glaciation, the lakes that were formed by the ponding-back of the drainage against the flanks of the ice-sheet lie to the east of the watershed of the peninsula. These observers have ascertained that when this ice-sheet was waning, it retreated eastward from the backbone of the country and lay on the eastern or Swedish slope, leaving a gradually increasing breadth of ground clear of ice. The streams flowing eastward over this liberated area had their drainage arrested against the margin of the ice; and hence arose a vast series of lakes which lasted for longer or shorter periods, until, by the continued creeping backward of the ice, their contents were drained off to lower levels. A multitude of records of old water-levels, or "strand-lines," was thus left over the surface of the country. It is the opinion of Scandinavian geologists that all the terraces not of marine origin lie within that area.

As one of the distinctive characters of the shore-lines left by the glacier-lakes, the author of the "Antlitz der Erde" cites the occurrence of the rock-shelves or platforms (seter) eroded out of the solid rock, and he refers the origin of these common features of the fjords to the daily oscillations of temperature at the surface of the lakes. A reference to the abundant examples of such rock-shelves in our own islands showed that this explanation is at least inadequate. If, however, for a moment, we grant that the strand-lines, including the seter of the Norwegian fjords, do mark levels of former fresh-water lakes, it is obvious that, in order to pond the drainage back and produce these lakes, the mouths of the fjords must have been in some way blocked up by a barrier which has disappeared. If this barrier were land-ice, as Prof. Suess appears to assume, the water would rise behind it, until, if the overflow found no escape into the Atlantic, it would pass over the watershed, and joining the various bodies of water that were there intercepted by the great Swedish ice-sheet, would eventually find its way into the Gulf of Bothnia. There would thus be two huge bodies of ice, between which the drainage was accumulated. We must remember, however, that the strand-lines are not confined to the fjords, but sweep round the coast on either side, and even appear on the islands that flank the mainland of Norway, some of them actually looking out to the open sea. The supposed ice-sheet must therefore have lain mainly outside these islands. But there is absolutely no evidence of any such detached western ice-body, and every reason to believe that it never existed.

At the period of maximum glaciation the ice-sheet probably advanced westward beyond the present limits of the land. But, when it began to retreat, it would naturally creep backward up the fjords, which would be still the main lines of ice-drainage. We can conceive, indeed, that at an early stage of this retreat, a glacier or ice-lobe may here and there have blocked up a large valley and produced a lake, as in the instances cited by Prof. Suess from Greenland. But the strand-lines of western Norway are not exceptional phenomena. They continue as characteristic features of the coast-line and of the fjords for several hundred miles, and must owe their origin to some general and widely extending cause. That they are true sea-beaches, as has been generally believed, Sir Archibald Geikie had not the smallest doubt.

Fortunately, we possess in our own islands a body of evidence bearing on this question, not certainly as voluminous and impressive as that of Scandinavia, but having the compensating advantage of great simplicity and clearness. On the one hand, the famous Parallel Roads of Glen Spean and Glen Roy, and those of other less known valleys, stand out as acknowledged relics of glacier-lakes; while round our coasts, on both sides of the country, raised beaches, which have been hitherto regarded as old sea-margins, run for hundreds of miles. These two series of terraces are found close together, yet there is no difficulty in drawing a satisfactory distinction between them. Indeed, their proximity enables us all the more clearly to perceive their contrasts.

There must, of course, be certain general resemblances between the littoral formations of lakes and of the sea. The erosion produced by the waves or wavelets of a body of fresh water is similar in kind to that performed by the sea, although different in degree. In like manner, the beaches of deposit formed in lakes possess, on a minor scale, many of the characters of those accumulated along the seashore. And it may readily be granted that, in isolated exposures of some old beach, it may be difficult or impossible to decide, in default of evidence from elsewhere, whether the phenomena observable are to be assigned to the work

of the sea or of a lake. Nevertheless, on a review of the whole evidence, at least as it is presented in this country, Sir Archibald felt very confident that there is no risk of confusion in this matter. The marine terraces maintain their distinctive features up to the very foot of the slopes where the lake terraces begin, while those in turn are marked by other special peculiarities.

Let any observer who has followed the great 50-foot raised beach along the western coast of Scotland and up the Linnhe Loch to the mouth of the Great Glen, look away to the right hand where the wide Strath of Spean leads into the interior. While yet standing on the platform of the raised beach, if the air be clear, his eye may detect the beginning of a line, drawn as with a ruler, at the same height along the slopes on either side of the valley. This is the lowest of the three great Parallel Roads of Glen Roy, and runs at a height of 850 feet above the level of the sea. If he will now ascend into Glen Roy, where the three terraces are best seen, he will soon be struck by the distinctive differences between these old lake-margins and the raised beaches with which he has already made himself familiar. In the first place, he will remark their faintness as compared with the marine platforms of the coast. Though readily traceable from a distance in their horizontal continuity, they are in many places hardly discernible when one is actually standing upon them. A little examination soon reveals that each of them has been produced mainly by the arrest of sediment washed from the slopes above into the water of the vanished lake. Instructive illustrations of this process may often be observed along the sides of reservoirs which have been constructed in steep-sided valleys: there each prolonged halt of the water at a particular level is marked by a shelf of detritus which, blown in by wind and washed down the declivities by rain, is stopped when it enters the water, where it accumulates as a miniature beach.

Here and there, especially on more exposed projections of the hillsides, there has been a little cutting-back by the shore-waves or drifting ice-floes of the old lake in Glen Roy. Occasionally also, where a streamlet has entered the water, its arrested detritus has accumulated as a broad, flat delta or terrace. But it is manifest that, in such limited expanses of water, wind-waves could have had comparatively little erosive power. Nor can we imagine that, even if the water froze, its floe-ice could have had any potent influence in sawing into the rocks of the declivities, and producing seter or rock-shelves. Certainly throughout this wonderful assemblage of lake-shores, there is nothing for a moment to be compared to the incised platforms of rock so abundant as part of the raised beaches of the western coast of Scotland. We must remember also that the production of such ice-dammed lakes took place as a mere episode in the retreat of the ice. No means are available to determine what may have been the length of time during which the water stood at the level of any one of these Parallel Roads. We may probably infer, from the absence of well marked and continuous intervening shore-lines, that the shrinkage of the ice and the consequent lowering of the level of the water were somewhat rapid.

The Parallel Roads of Lochaber, although the most imposing, are not the only examples of the shore-lines of ancient glacier-lakes in this country. Another striking case is that of Strath Bran in Ross-shire, where the glaciers descending from the mountains on each side ponded back the drainage of the valley, and sent it across the present watershed of the country at a height of about 600 feet above the sea. The conspicuous gravel-terraces at Achnashean are a memorial of this vanished sheet of water.

Now, with these undoubted records of ancient lakes, let us compare the structure and distribution of our Raised Beaches. These shore-lines are found, on both sides of Scotland, at approximately the same heights above the level of the sea. They are partly terraces of deposit, and partly true seter or platforms cut out of the solid rock, the same beach presenting frequent alternations of both structures. In general, it may be said that the detrital terraces are found chiefly in bays, sea-lochs, or other sheltered places, while the rock-terraces are conspicuous in more open sounds and exposed parts of the coast, where the tidal currents and wind-waves are most powerful.

As the highest terraces are the oldest, they have been longest exposed to the influences of denudation, and are thus the faintest and most fragmentary. But the dimensions and perfection of a raised beach do not depend merely on age, but in large measure on the length of time that the water stood at that level, and the varying local conditions that favoured or retarded the planing-down of solid rock or the deposition of littoral sediment.

That these beaches unquestionably mark shore-lines of the sea may be inferred on three grounds:—(1) Their position on both sides of the island at corresponding heights. No possible arrangement of ice-dams in the Atlantic and in the basin of the North Sea can be conceived that would have everywhere ponded back the land-drainage to similar levels. (2) Their independence of local conditions. The same terrace may be traced down both sides of a sea-loch and round the coast into the next loch, retaining all the while its horizontal continuity. Not only on the mainland, but on the chain of islands outside, the same parallel bar has been incised, both on the inner or sheltered side and also on the outer flank looking to the open Atlantic. (3) Their organic remains. From the youngest of the beaches up to the highest, the terraces of deposit contain marine organisms which have not been scooped out of some earlier formation, but lie in the positions in which the animals died, or into which they were washed by shore-waves and currents. The fossils of the latest beaches are entirely identical, or almost so, with forms still living in the adjacent seas, while those of the higher beaches are boreal or Arctic.

In some sheltered places, such as the Dornoch Firth, especially near Tain, and some inlets on the west side of the island of Jura, a number of successive bars or terraces of deposit may be observed up to heights of 100 feet or more above the sea. But there are in Scotland three strand-lines so conspicuous and so persistent that attention may be confined to them. From what has been taken to be their average height above mean sea-level or Ordnance-datum, they are known respectively as the 100-foot, the 50-foot, and the 25-foot beaches.

The author here adverted to what he had long regarded as a reproach to the geologists of this country. No systematic effort has ever yet been made to determine accurately, by a series of careful levellings, the precise heights of these old shore-lines. We only know that, roughly speaking, a raised beach retains its level for long distances, and appears to lie at the same height on both sides of the country. But we are still ignorant whether or not an appreciable difference of level might not be detected between the western and the eastern development of the same beach, nor do we know whether it would not betray some variation in its height between its northern and southern limits. There seems to be a tendency for the levels of the beaches to rise slightly towards the head of an estuary or sea-loch. But whether this difference is more than can be accounted for by the ordinary elevation of the tidal wave as it ascends a narrowing inlet remains to be determined.

Obviously, until accurate information is obtained on all ascertainable differences of level in the system of our raised beaches, we must remain unprovided with some of the most important material for a discussion of the history of these beaches. It is surely not too much to hope that one or more observers, endowed with the requisite geological knowledge and geodetic skill, may before long be found who will undertake the investigation of this interesting subject, and thus aid in the solution of a problem which does not merely concern the evolution of our own islands, but is of high importance as a question in geological theory.

The 100-foot, 50-foot and 25-foot beaches of Scotland were briefly described, and it was pointed out that in the structure of these old sea-margins a feature of special interest is presented by the platforms which have been eroded out of the solid rock, and which afford not a little light as to the origin of the Norwegian seter. The surface of these rock-terraces is flat, and usually covered with a thin coating of grass-grown soil through which harder knobs and stacks of the underlying rock here and there protrude. At the inner margin of the terrace, the rocks rise into a cliff or steep bank, the base of which is frequently pierced with caves. That these caves were mainly due to erosion by moving water is abundantly evident in

the rounded and smoothed surfaces of their sides. Their floors are often rough with round shingle, which has undoubtedly been the material employed by nature in their excavation. No one who has made himself familiar with the rock-platforms which at the present day are in course of erosion by the sea along these same coasts can for a moment doubt that the rock-platforms of the raised beaches which, down to the minutest point, resemble them, have likewise been eroded by the waves of the sea.

That the daily oscillations of temperature invoked by Prof. Suess in explanation of the Norwegian seter have had their share in the erosion of these Scottish examples cannot be doubted. But this share is evidently feeble in amount now, although it may have been more considerable during the Glacial period. More potent as a contributory influence in the erosion of the older terraces was probably the action of floating ice, driven along the shores by winds and tidal currents. Down to the time of the 50-foot beach, when glaciers in the north of Scotland descended to the edge of the sea, there may have been a good deal of such ice in the more enclosed sea-lochs, where the water, freshened by the discharge of melting snow-fields and glaciers, might itself be covered with a cake of ice. And there was not improbably a good deal more ice in the fjords of Norway. The grinding and rasping action of such ice, driven by gales ashore, has long been remarked. But in any case we are justified in regarding the Scottish seter as examples of truly marine erosion, and there appears to be no reason why those of Norway should not have had the same origin. It is at least clear that the statement that the characters of seter "are absolutely irreconcilable with what we know of the action of the sea near its surface," cannot be sustained.

Certain features of the extension of the raised beaches throughout Britain appear to be of fundamental importance in relation to the discussion of the problem of the emergence of land. Though so persistent along both the western and eastern coasts of Scotland, these beaches, as is now well known, do not stretch northward into the Orkney and Shetland Isles. Along precipitous sea-fronts we could not expect to meet with them, but among these islands there are endless sheltered inlets and bays which, had they indented the shores of the mainland of Scotland, would undoubtedly have had their fringe of terraces. The conditions for the development and preservation of the beaches were so entirely favourable, that their absence can only be legitimately accounted for on the supposition that they can never have existed here. Still farther north, among the Færöe Isles, no trace of any raised beaches has been found among the numerous natural harbours and creeks that break the monotony of the vast ranges of basalt-precipice. Here, again, we cannot suppose that any such beaches were ever formed.

In the southward extension of the Scottish raised beaches these features begin to lose their distinctness as they are traced into England. The 100-foot beach, which has not been recognised along the northern coast of Sutherland or in Caithness, appears also to fail before it reaches the English coast. It is well marked in the estuaries of the Clyde and Forth, whence in a fragmentary condition it has been traced into Wigtonshire on the one side and to the north of Berwickshire on the other. But no remnants of it appear to have been detected in the North of England.

The raised beaches of the north and east of England were briefly referred to, and it was then shown that in England and Wales the most continuous and best preserved examples are to be seen on the coasts of the southern counties. The lower raised beaches along the coasts of Dorset, Devon and Cornwall have long been known, although their geological age, their history, and their relation to the later phases of Pleistocene time, have not yet been satisfactorily cleared up. William Pengelly, who devoted so much time to this subject, clearly proved that these beaches do not stand now at their original level, but that after their formation the region was upraised to the amount, as estimated by him, of not less than 70 feet, when the lowest sunk forests flourished as land-surfaces, and that thereafter came a submergence of certainly 40 and perhaps many more feet.

Mr. Tiddeman has shown that, in Gower, on the coast of Glamorgan, a raised beach which lies from 10 to 30 feet above the level of the modern beach, and contains littoral shells of common species, is yet older than at least some part of the Glacial period, for it is overlain by Glacial drift. In this case, also, its present is probably not its original level. There is evidence of considerable submergence, at a comparatively late period, farther east in the same county and along the southern coast of England, and the inter-Glacial or pre-Glacial raised beaches of the whole of this region doubtless stood at one time higher above the sea-level than they do now.

The raised beaches of Ireland were alluded to, special attention being directed to an ancient shore-line at Cork Harbour, which has recently been traced by Messrs. Muff and Wright, of the Geological Survey, not only within the harbour, but for a long distance on the shore to the east and west of that inlet. Though only a few feet above the present high-water mark, this beach has been ascertained to be older than the oldest Irish Boulder-clay, for it is overlain by the so-called "shelly marl" which was brought in upon the land from the sea-basin. The similarity of position and antiquity between this beach and that underlying the drift in Gower is obviously as important as it is interesting. A shore-line, which must be of pre-Glacial or inter-Glacial age, is traceable in the south of Ireland and in South Wales. It has not only survived the erosive processes of the Glacial period, but it appears to have outlived some serious alterations in the relative levels of sea and land, which have taken place since its formation. Moreover, we have to note the fact that neither at Cork nor in Gower does any younger post-Glacial terrace appear to be recognisable. If we might judge from the analogy of other parts of these islands where the succession of raised beaches is tolerably complete, we should infer that if ever any later terrace existed here it must now be submerged—an inference which, it will be observed, is supported by the evidence of considerable submergence in South Wales and on the southern coast of Hampshire.

(ii.) *Submergence.*—Of the various kinds of proof of the submersion of terrestrial surfaces furnished in these islands only two were dealt with: first, the extension of land-valleys beneath the sea, and, secondly, the existence of what are known as sunk forests.

(1) That the fjords of Norway, the sea-lochs of the west of Scotland, and the harbours or inlets of the west of Ireland were originally valleys on the dry land, although now deeply submerged, has long been an accepted belief among those geologists who have specially considered the subject. The interval of time which has elapsed since this submergence has not sufficed to fill up with sediment these submarine depressions. By a study of the sea-charts, we can still trace the winding curves of the ancient valleys, and can even here and there detect among them the basins which, when the present sea-bottom was a land-surface, were filled with fresh-water lakes. On the sea-floor to the east of our own country and of Scandinavia, such relics of subaërial denudation are less imposingly preserved, yet evidence of the submergence of land-valleys has been noted there also. It must of course be remembered that the land on that side is of much lower altitude than on the western coasts, that the ground slopes gently under the sea, and that the valleys are comparatively insignificant depressions on its general surface. Moreover, the more abundant drainage on the longer slope east of the watershed, and the much greater development of drift on that side, leads to a far more copious discharge of sediment into the shallow North Sea and the Gulf of Bothnia, and the submarine prolongations of the old land-valleys are thus apt to be buried under recent accumulations of detritus. There may, however, perhaps be another cause for the contrast between the profoundly indented and precipitous western coast and the comparatively low and monotonous trend of the eastern coast. The author had long been disposed to believe that the submergence has been greater towards the west than towards the east. In the prolongation of the West Highland sea-lochs on the floor of the Atlantic outside, the original land-surface sometimes lies 600 feet or more below the present sea-level. If the submerged land-surface of north-western Europe could be upraised some 600 feet, the submarine prolongations of the sea-lochs would once more become glens and straths, and their rock-basins would again be turned into fresh-water lakes.

There is no similar series of well marked submerged valleys on the floor of the North Sea from which to estimate the amount of submergence of that tract, at least half of which, at no very distant date, formed a land-surface that connected Britain with the rest of the Continent. The charts show this sea-floor to consist of two distinct portions. The northern half forms a plain, which appears to slope gradually towards the north. The southern half, however, rises somewhat rapidly from the edge of that plain into an escarpment that runs in a north-easterly direction for a distance of 500 miles, from off Flamborough Head to the Skagerrak. From the top of this escarpment the surface undulates southward as a higher submarine plain, traversed by the still feebly traceable submerged valleys of the Elbe, the Rhine, and the Thames, and covering an area of more than 50,000 square miles. An uprise of not more than 300 feet would turn this tract into a rolling plateau of dry land, like the downs and wolds of Yorkshire, which are its emerged continuation. Such an amount of uplift would probably be amply sufficient for the transaction of all the later geological history of the region. The conversion of the area into a sea-bottom may not have been a continuous process. It was probably in operation during the early stages of the Glacial period, and its latest phases come down at least into Neolithic time.

(2) The sheets of peat with stools and trunks of trees, known as sunk or submerged forests, and of such frequent occurrence around the coasts of the British Isles, have long been confidently regarded as proofs of recent subsidence of the land. That they generally mark former land-surfaces cannot be doubted, for the tree stumps are seen to send their roots down into the soil underneath, and manifestly stand in the places where they originally grew. The presence of hazel-nuts, elytra of beetles, land-snails, and other terrestrial organisms, affords further confirmation of this conclusion. The great majority of these vegetable accumulations are found between tide-marks in bays and estuaries, and in many cases they can be seen to pass below the limits of the lowest tides, and thus to be constantly in part submerged. The trees and the fresh-water plants must have lived above the reach of the sea, so that they now lie 20 feet or more below the level at which they originally grew, and the conclusion has been drawn that they mark a general subsidence of these islands, to the amount of at least 20 feet, at a comparatively recent date.

Sir Archibald Geikie was inclined to believe that this conclusion has been rather too sweepingly drawn. That some of the submerged forests may be satisfactorily accounted for without any change in the level of the land or of the sea was urgently enforced more than eighty years ago by John Fleming, in reference to the examples first brought to notice by him in the estuaries of the Tay and the Forth. It will be readily understood that, in the later stages of the Glacial period, when much detritus was swept off the land into the sea, the conditions would probably be especially favourable for the formation of alluvial bars along our coasts, such as are now in course of accumulation for hundreds of miles on the southern coast of Iceland, where some of the features of that period may still be said to linger. Behind these barriers lagoons would arise, which in course of time might become marshes, and eventually peaty flats, supporting a growth of trees. But when the supply of sediment failed, and the sea, instead of heaping up the bars, began to breach them, the level of the bogs would sink by the escape of their water to the beach, and the tide at high-water would overflow and kill off the forests. Occasionally, owing to the action of underground drainage, the seaward margins of forest-covered peaty flats may have been detached from the main body and launched downward on the beach, even beneath low-water mark.

Had our littoral sunk forests been confined to a few places where the topographical conditions were specially favourable for their production, we may concede that they would not in themselves furnish sufficient proof of a shift of level, either on the part of the land or of the sea. But when we consider their widespread distribution all round the margin of these islands, even on those shores where it is difficult to believe that there has been any subsidence or slipping downward of a land-surface owing to the draining off of underground water, we may well doubt whether the old belief should be disturbed, that the facts, taken as a whole, prove a general submergence.

Fortunately, the evidence available on this subject allows us to go a step farther. We need not be content with such debateable proofs as are furnished by the sunk forests between tide-marks, for land-surfaces can be adduced which are buried beneath marine accumulations in circumstances that leave no doubt as to the facts of submergence.

The author, after presenting some details proving submergence at Belfast, at Hull, and at Grimsby, to the extent of sometimes as much as 52 feet, stated that on the coast of South Wales interesting sections had been laid open in the excavation for the Barry Docks, in Glamorgan, furnishing conclusive proof of a succession of at least four layers of peat overlain by estuarine deposits, and in a situation which precludes any recourse to local settlement by drainage of underground water or downward slipping. The strata are manifestly undisturbed, and the lowest is an unmistakable land-surface. It consists of peat full of remains of oak, hazel, cornel, hawthorn, and willow, together with crushed shells of Hyalinia and, apparently, Pisidium and Planorbis. The soil underneath this forest-growth has yielded specimens of Helix, Hyalinia, Succinea, Limnæa, Pupa, and Valvata. This buried forest-growth lies at a depth of 35 feet beneath Ordnance-datum, or 55 feet beneath the line of high-water of ordinary spring tides. It proves a submergence of at least 55 feet, and the peat-bands at higher levels mark successive pauses in this submergence. That the movement was in progress in Neolithic time may be concluded from the occurrence of a portion of a polished celt in the uppermost layer of peat, from which also two bone needles are reported to have been obtained. Mr. Strahan informed the author that, wherever excavations have been made at the mouths of the valleys on the coast of South Wales, similar layers of peat have been cut through at depths below low-water mark. It would thus appear that the submergence has been general all along the coast-line.

On the southern English coast similar evidence of a considerable change of level has long been known. During the extensive excavations for new dock accommodation at Southampton, a bed of peat, 10 feet thick, has been found, descending to a depth of 43 feet below Ordnance-datum. This vegetable accumulation has yielded many land and fresh-water shells; abundant trunks of oak with roots, sometimes 2 feet long, passing down into the loam beneath; plentiful remains of beech and hazel, together with some birch and pine. The plants also include bulrush, sedge, bog-myrtle, heaths, and bracken. From this bed, bones, horn-cores, and part of the skull of *Bos primigenius* were obtained; likewise horns and bones of red deer, tusk of boar, bones of hare, and horn of reindeer. Traces of man were found in the same deposit, as shown by the occurrence of dark flint-flakes, a round perforated hammer-stone, and a fine bone needle polished by use.

There is thus evidence of a comparatively recent submergence of the south-west of England to the extent of at least 50 or 60 feet. We are probably justified in considering the present position of the Glacial raised beach in Gower as a further indication of the same movement, and there seems no reason why we should not connect the evidence of this beach with that of the terrace lately detected in Cork. If these tracts are included in our survey, we see that the submergence probably stretched across South Wales and St. George's Channel to the south of Ireland. The evidence from Hull and Grimsby, which shows that a similar marked submergence has taken place along part of the east coast, not improbably indicates that the change of level extended across Wales and the centre of England. This submergence appears to be the latest in the long series of oscillations which have affected the southern portions of our islands. No proof has yet been obtained that so serious an amount of recent submergence has extended farther north. In the northern tracts the latest recorded change of level has been an emergence of the land in Neolithic time.

(iii.) *Bearing of the Evidence on the Causes of Emergence and Submergence.*—In conclusion, the author pointed out the inferences that appeared to him to be deducible from the

evidence obtainable in the British Isles, in regard to the causes which, in this region, have determined the emergence and submergence of land. The vertical range of the changes of level to which the discussion in this address was limited amounts at least to as much as 700 feet, that is, some 600 feet below and 100 feet above the surface of the sea. But it will be remembered that, if we include all the deposits that contain recent marine shells *in situ*, the range of movement will be found considerably to exceed 1000 feet. The problem to be solved is whether this wide amplitude of shift in the relative levels of sea and land should be attributed to variations in the height of the surface of the oceanic envelope, or to secular movements of the terrestrial crust.

Any change of sea-level might be expected to be general and fairly uniform over long distances. The area of the British Isles is too restricted to permit us to believe that there could ever have been any serious difference in sea-level between the eastern and western coasts, or between the northern and southern limits of the country. Whether, therefore, the surface of the sea rose upon the land or sank away from it, we should find the records of these changes to extend over the entire region, and to be marked on the whole by a persistent uniformity of level. But an examination of the evidence fails to furnish proofs of any such extension and uniformity.

In the first place, the raised beaches, although so perfectly developed over nearly the whole of Scotland, disappear towards the north among the Orkney and Shetland Islands where, had they ever existed, they had every chance of being as well preserved as anywhere on the mainland. These islands obviously lay outside of the area affected by the movement that led to the formation of the beaches. But they could not have escaped from the effects of any rise in the level of the sea. Again, it is incredible that if the great 100-foot terrace, so prominent a feature in Scotland, had been formed by an uprise of the surface of the sea, the same terrace should not have been visible in thousands of favourable positions in England, Wales, and Ireland. Its entire absence cannot be accounted for by the presence of former ice-sheets in these regions, or by subsequent denudation. This absence may surely be taken as proof that the terrace never extended over these parts of our islands.

In the second place, had the position of the buried forests in the southern half of England and Wales been due to a rise in the sea-level, similar evidence of submerged land-surfaces at corresponding depths should have been met with generally round our coast-line. Neolithic man was an inhabitant of the country before this submergence was complete, and has dropped his handiwork in the beds of peat. In the north of Ireland and in central Scotland, however, during Neolithic time the land was emerging from the sea, and man has left his flint-flakes and weapons in the youngest raised beaches. Thus in the same period of geological time the sea-level must be supposed to have risen 50 or 60 feet in the south, and to have sunk 25 or 30 feet in the north. But we cannot suppose that within a distance of 300 or 400 miles there could have been a difference of 75 feet or more in the level of the water.

In the third place, there can be little doubt that when accurate levellings are taken of the raised beaches, it will be found that their apparent horizontality is not absolute, but that they rise slowly in certain directions, more particularly towards the axis of the country. It is not improbable also that a difference of level will be detected between the same beach on the eastern and on the western coast, and between its most northerly and most southerly parts. Such evidence of a deformation of the land can only be determined by careful geodetic measurements still to be undertaken.

In the meantime, on a review of the whole evidence, the author felt confident that the balance of proof is largely in favour of the old belief that the changes of level, of which our islands furnish such signal illustrations, have been primarily due, not to any oscillations of the surface of the ocean, but to movements of the terrestrial crust connected with the slow cooling and contraction of our globe. If this belief is to be overthrown, better evidence must be brought against it than has been hitherto adduced.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—On Saturday, May 28, the following honorary degrees were conferred on foreign delegates of the International Association of Academies:—D.C.L., Chevalier Edouard Descamps (of the University of Louvain), Ministre d'État, Sénateur Belge. D.Litt., J. L. Heiberg, University of Copenhagen; M. Émile Senart, Académie des Inscriptions et Belles-Lettres, Paris; M. Boutroux, Académie des Sciences Morales et Politiques, Paris; Prof. Collignon, Académie des Inscriptions et Belles-Lettres, Paris. D.Sc., Prof. Dr. Flechsig (Leipzig), Kgl. Sächsische Ges. der Wissenschaften; Prof. E. Ehlers, Kgl. Ges. der Wissenschaften, Göttingen; M. A. Giard, Académie des Sciences, Paris; Dr. Victor von Lang, Kaiserl. Akad. der Wissenschaften, Vienna; Prof. H. Mohn, chairman of the committee of the Videnskabs Selskab, Christiania; and Prof. H. Obersteiner, of the University of Vienna.

A meeting of the Junior Scientific Club was held on May 27. Papers were read by Mr. R. T. Lattey, on "Electrochemical Actinometers," and by Mr. E. C. Atkinson, on "Surveying in South Africa."

The following are among the honorary degrees to be conferred at the Encænia on June 22:—D.C.L., Mr. Charles Booth, F.R.S., president of the Royal Statistical Society. D.Sc., the Hon. C. A. Parsons, F.R.S.; Prof. Pierre Curie; Sir W. S. Church; Sir Andrew Noble, F.R.S.; Sir William Crookes, F.R.S.; Sir David Gill, F.R.S.; Sir John Murray, F.R.S.; Prof. Alfred Marshall; Prof. J. J. Thomson, F.R.S.; Prof. Horace Lamb, F.R.S.; Prof. A. R. Forsyth, F.R.S.; Prof. Dewar, F.R.S.; and Prof. Larmor, Sec.R.S.

CAMBRIDGE.—The following are the speeches delivered by the Public Orator, Dr. Sandys, on May 28, in presenting the under-mentioned members of foreign academies for the degree of Doctor in Science, *honoris causâ*:—

PROF. BAKHUYZEN, OF LEYDEN.

Inter doctores nostros novos primus hodie progreditur Scientiarum Academiae Amstelodamensis praeses, Batavorum astronomus insignis. Abhinc annos septemdecim consilii magni inter auctores fuit, quo caeli totius stellae, luminis ipsius auxilio chartis impressae, accuratissime redderentur. Etiam altero in opere immenso cum aliis consociatus est, quo caeli parte Boreali in regiones sedecim divisa, stellarum multitudo infinita minutissime observaretur. Iuvat hodie recordari caeli regionem astronomo Leidensi assignatam regioni Cantabrigiensi esse conterminam. Idem latitudinis (ut aiunt) varietatem, orbis terrarum axe leviter vacillante exortam, diligenter exploravit. Talium virorum ope Europae gentes scientiae amore excitatae, etiam in orbe terrarum accuratius dimetiendo invicem certant, astronomi illius antiqui laudem aemulatae,

"descripsit radio totum qui gentibus orbem."

PROF. FAMINTSYN, OF ST. PETERSBURG.

Russorum ab imperio adest botanicae professor eximius, qui studiorum provinciam nactus pulcherrimam, rerum omnium, quas terra gignit, physiologiam inter primos exploravit. Quam exquisitis usus experimentis, ostendit artificio quam admirabili herbarum genus omne solis radiis tactum virescat; etiam subter aquas algae minutissimae motu tremulo vibrent; foliorum denique omnium in cellis primordia quaedam viriditatis sese explicent, sed eadem solem nimium reformident. Quam feliciter idem novo lumine rem obscuram illustravit, vitamque illam communem, quae inter animalia quaedam minutissima et algarum cellulas intercedit, diei in lucem nuper protraxit.

"sic unumquicquid paulatim protrahit aetas
in medium, ratioque in luminis erigit oras."

EDMUND MOJSISOVICS, EDLER VON MOJSVÁR, OF VIENNA.

Vindobonensium ab Academia insigni ad nos advectus est vir de geologia praeclare meritus, qui duodequadraginta per annos palaeontologiae studiis deditus, Ammonis praesertim cornua, rupium in sinu insculpta, aevi prioris indicia (prope dixerim oracula) verissima existimavit. Quid dicam

de montium Dolomitorum serie et in Rhaetia et prope Venetos ab eodem dilucide descripta? quid de ratione illa quam inter Europae atque Asiae montes maximos intercedere indicavit? Oceanum certe ingentem, quem ex mari Mediterraneo ad oceanum Pacificum quondam extendere magister eius probavit, argumentis novis revera exstitisse discipulus confirmavit, ultraque Atlantida quandam, etiam maris "Arcto-Pacifici" fines antiquos determinavit. Nemo mortalium fortasse Oceanorum antiquorum amplitudines metiri audacius conatus est, nemo tot Alpium ingentium varietates accuratius inter sese comparare.

EMERITUS PROF. RETZIUS, OF STOCKHOLM.

Scandinavia, cuius etiam Regem inter doctores nostros numeramus, auspiciis optimis ad nos misit anthropologiae physicae conditoris insignis filium illustrem, qui anatomiam olim praeclare professus, eidem scientiae etiam otium suum et annos emeritos destinavit. Peritis nota sunt volumina illa maxima, eademque et typorum et imaginum splendore pulcherrima, et cerebri ipsius et sensuum omnium anatomiae et physiologiae explicandae dedicata. Idem, patriae non immemor, etiam Scandinaviae priscae "crania antiqua," arte eximia depicta, in libro singulari ordinavit. O terram felicem, quae non modo regia in domo artium et scientiarum tot cultores, tot patronos, numerat, sed etiam inter professores suos virum munificentia prope regia insignem non immerito admiratur.

PROF. RIECKE, OF GÖTTINGEN.

Academiae Goettingensis, et regiae domus Hanoverianae vinculo antiquo et hospitii iure vetere nobis coniunctae, socium eximium salutamus, qui scientiae physicae provincias multas peragravit; qui et de vi electrica cum crystallis consociata, et de corpusculis illis electricis inter nosmet ipsos primum indicatis, non minus breviter quam dilucide disputavit; qui denique, in scientiae illius experimentis libro in unico explicandis, inter tot res minutissimas ab alio aut alio observatas, rationem ipsam ubique eminere et apparere passus est. Illa vero rerum omnium domina est; illa nos praesertim et in scientiarum inventis praeteritis delectat et spe maioris in posterum incrementi excitat. Etenim de studiis ad lucis leges pertinentibus, non minus quam de ipsa luce, poëtae antiqui verba illa vera sunt:

"suppeditatur enim confestim lumine lumen
et quasi protelo stimulatur fulgere fulgur."

PROF. WALDEYER, OF BERLIN.

Academiam Berolinensem, et in scientiis et in litteris celeberrimam, oculis nostris quasi praesentem hodie reddit vir eximius, Academiae ipsius in scientiis physicis et mathematicis alter e ministris praecipuis, qui anatomiae in provinciis plurimis plurima cum laude versatus, vitae nascentis praesertim e studiis famam singularem est adeptus. Neque vitae ipsius circa limina obscura moratus, etiam urbium magnarum in lucem progressus est. Is certe, qui morum urbanitate et sermonis eloquentia anatomiae professores illos antiquos, Herophilos et Erasistratos, sine dubio superavit, est profecto, velut alter Hippocrates medicinae pater a Celso laudatus, "vir et arte et facundia insignis."

THE honorary degree of Doctor in Letters was conferred upon the Comte de Franqueville, sometime president of the Institute of France; Prof. Goldziher, member of the Hungarian Academy of Sciences and professor of Semitic philology in the University of Budapest; Prof. Gomperz, Emeritus professor of classical philology in the University of Vienna; Prof. Krumbacher, member of the Royal Bavarian Academy of Sciences and professor of mediæval and modern Greek philology in the University of Munich; M. Paul Leroy Beaulieu, of the Institute of France; and M. Georges Perrot, member of the Institute of France.

MR. W. GARDINER, F.R.S., Clare, Prof. C. S. Sherrington, F.R.S., Caius, and Mr. G. T. Walker, F.R.S., Trinity, have been approved for the degree of Doctor of Science.

The John Lucas Walker studentship in pathology, value 200*l.* a year for three years, will be vacant at Michaelmas. Applications are to be sent to Prof. Sims Woodhead before June 27. The student need not be a member of the university.

It is proposed to appoint a demonstrator of surgery, a demonstrator of experimental psychology, and an assistant curator of the museum of botany.

Sixty-seven men and twenty-two women have acquitted themselves so as to deserve honours in the mathematic tripos. The class list will be published on June 14.

A "NATURE STUDY" museum at St. George's Recreation Ground, Cable Street, E., will be opened to-morrow, June 3, at 5 p.m., by Sir William J. Collins, chairman of the Education Committee of the London County Council.

THE governing body of the Northampton Institute has decided to establish day classes in technical optics at the institute next winter. These courses will include full time courses, in which students will attend about thirty hours per week, and also morning classes for two mornings per week for those already engaged in the industry. An appeal is being made to members of the optical trade for donations towards the support of these technical classes with a view to the establishment and maintenance of British supremacy in the optical industry. It is reported that the London Education Committee will proceed shortly to consider the establishment of a central optical institute or college, and it is probable the decision arrived at will depend largely upon the attitude of the optical trade towards classes such as those at the Northampton Institute.

A REPORT prepared by the preliminary scientific education and examination committee of the General Medical Council was considered at the meeting of the council on Friday last, and the following resolutions were passed:—(1) That an examination in chemistry, in order to be sufficient, should comprise a written paper, a practical examination, and an oral examination; (2) that, in respect of chemistry, a synopsis or syllabus of subjects should be issued by each licensing body, and that the scope of the examination in chemistry should not fall below that which has been indicated in the report of the visitors, and has been generally approved by the licensing bodies; (3) that the examination in practical chemistry should not be limited to simple qualitative analysis, but should include easy preparations, simple volumetric analysis, and simple experiments illustrating important principles; (4) that an examination in physics, in order to be sufficient, should comprise a written paper and an oral examination, the latter to include practical questions on the use of physical instruments and apparatus; (5) that, in respect of physics, a synopsis or syllabus of subjects should be issued by each licensing body, and should include the elementary mechanics of solids and fluids and the rudiments of heat, light, and electricity; (6) that elementary biology should be retained in the curriculum; (7) that an examination in elementary biology, in order to be sufficient, should comprise a written paper and an oral examination, the latter to include practical questions on specimens and dissections, and on methods of microscopical investigation; and (8) that, in respect of elementary biology, a synopsis of subjects should be issued by each licensing body.

THE "Code of Regulations for Public Elementary Schools" for 1904 has been issued by the Board of Education. It has been much simplified, both in phraseology and arrangement. In the place of detailed schemes of work in a multitude of subjects suitable for the seven standards of an elementary school, the Board has sketched in broad outline a graduated course of instruction on which the education given in every public elementary school should be based. In this course of instruction a prominent place is given rightly to a "knowledge of the common phenomena of the external world, with special reference to the formation of a habit of intelligent and accurate observation, and to the application of that habit—in conjunction with simple forms of experiment—in the daily life and surroundings of the scholars." Nor is this the only opportunity taken by the Board, in this important official document, to show clearly its belief in the value and essential nature of scientific work in all schemes of education. An introduction to the code defines the purpose of an elementary school education as being "to form and strengthen the character and to develop the intelligence of the children." The introduction continues later to say that "with this purpose in

view it will be the aim of the school to train the children carefully in habits of observation and clear reasoning, so that they may gain an intelligent acquaintance with some of the facts and laws of nature." The importance of practical work and manual instruction is duly emphasised. This recognition of the claims of natural knowledge to an honoured place in the work of our primary schools will go far to reward men of science for their efforts to convince educational authorities of the value of scientific training. It is to be hoped that elementary school teachers will take full advantage of their new charter, and show by the improvement of their work that they value their new freedom to educate on rational lines.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 5.—"On certain Physical and Chemical Properties of Solutions of Chloroform in Water, Saline, Serum, and Hæmoglobin. A Contribution to the Chemistry of Anæsthesia.—(Preliminary Communication.)" By Benjamin **Moore,** M.A., D.Sc., Johnston Professor of Bio-chemistry, University of Liverpool, and Herbert E. **Roaf,** M.B., Toronto, Johnston Colonial Fellow, University of Liverpool.

Summary and Conclusions.

(1) It is believed that the experiments recorded in this paper justify the conclusion that chloroform forms an unstable chemical compound or physical aggregation with the proteids experimented with, and that it is carried in the blood in such a state of combination. Since proteids build up the protoplasm of living cells, it appears to us probable that chloroform, and other anæsthetics, must form similar combinations with protoplasm, and that anæsthesia is due to the formation of such compounds which limit the chemical activities of the protoplasm. The compounds are unstable, and remain formed only so long as the pressure of the anæsthetic in the solution is maintained. Such compounds are formed not only by hæmoglobin, but by serum proteid, and hence the position taken by the anæsthetic in hæmoglobin is not that of the respiratory oxygen. This is further shown by the fact that the oxygen-carrying power of hæmoglobin is not interfered with in presence of chloroform.

The effect of chloroform upon various forms of protoplasm will form the subject of future experiments.

The facts upon which we rely as proofs of the formation of a compound or aggregation between chloroform and serum proteid or hæmoglobin may be summarised as follows:—

(*a*) Chloroform has a much higher solubility in serum or hæmoglobin solutions than in saline or water.

(*b*) *Even in dilute solutions* at the same pressure the amount of chloroform dissolved in serum or hæmoglobin solution is considerably higher than in saline or water.

(*c*) The curve of pressures and concentrations in the case of water and saline is a straight line, while in the case of serum and hæmoglobin solution it is a curve, showing association at the higher pressures.

(*d*) In the case of serum, chloroform causes a marked opalescence, and also a slow precipitation at room temperature (15° C.), and at body temperature (40° C.) a rapid, though incomplete precipitation. In the case of hæmoglobin, 1·5 to 2 per cent. of chloroform causes a change of colour and commencing precipitation at room temperature, which becomes almost complete in the thermostat at 40° C., while 5 per cent. and over causes complete precipitation even at 0° C.

(2) The relations between chloroform pressure and concentration in solution have been worked out throughout a long range, from below the anæsthetising values (8 to 10 mm.) to nearly saturation in the case of water, saline, and serum.

Attention may be directed here to the important practical fact that with the same percentage of chloroform in the air breathed, serum or hæmoglobin, and therefore the blood will take up much more chloroform than would water or saline under equal conditions. Thus at the anæsthetising pressure, and at 40° C., the coefficient of distribution in the case of water and saline is approximately 4·6, while that of serum is 7·3; at room temperature (15° C.) these coefficients become 8·8 and 17·3 respectively.

"Note on the Lymphatic Glands in Sleeping Sickness." By Captain E. D. W. **Greig,** I.M.S., and Lieut. A. C. H. **Gray,** R.A.M.C.

The authors have examined the contents of lymphatic glands during life from fifteen sleeping sickness patients. In all of them actively motile trypanosomes were very readily found in cover-glass preparations taken from the cervical glands. They were also present in other glands, such as the femoral, but were not nearly so numerous.

The authors consider that their observations throw a new light upon the glandular enlargements which have been so constantly noticed in sleeping sickness, and that the disease is essentially a polyadenitis brought about by the arrest of the trypanosomes in the glands where many of them are destroyed, but whence some escape from time to time into the blood stream and thus occasion the increase which has been observed in the peripheral circulation.

They regard their observations upon the presence of trypanosomes in number in the lymphatic glands of both early cases of trypanosomiasis and advanced cases of sleeping sickness as affording important evidence of the unity of these diseases, and further proof that the trypanosomes are the essential cause of sleeping sickness.

"A Note on the Action of Radium on Micro-organisms." By Dr. Alan B. **Green.** Communicated by Sir Michael Foster, K.C.B., F.R.S.

The radium salt used in these experiments was 1 centigram of practically pure radium bromide, contained in a vulcanite and brass capsule fronted with thin talc. The emanations applied to micro-organisms were the β and γ rays.

(1) In the first set of experiments the germicidal action of these rays on various species of bacteria was investigated. A mass of bacteria was placed, as a thin layer, in a hollow-ground glass slide, and the capsule containing the radium was placed over the mass in such a way that the radium was brought within 1–2 mm. of it. All experiments and controls were made at room temperature.

It was found that the specific germ of vaccinia was killed by an exposure to radium of 22 hours or less. Non-spore-bearing bacteria were killed generally by 2 to 14 hours' exposure to radium, while spores were not killed by less than three days' exposure. It was further found that (*a*) as the distance between the radium and the bacteria was increased germicidal action became less evident and finally ceased; (*b*) as increased thicknesses of lead were interposed between the radium and the bacteria, *i.e.* as the β rays were cut off, germicidal action became less and less evident.

(2) It was ascertained that after exposure to radium at a distance of 1–2 mm. for 24 to 120 hours, micro-organisms themselves became radio-active. It has not yet been ascertained whether living micro-organisms can exhibit induced radio-activity, but micro-organisms killed by radium emanations show this activity. No radio-activity was found in bacteria not previously exposed to radium. The induced radio-activity of bacteria was shown by the ability of a mass, after exposure to radium, to photograph itself when brought into apposition with the film of a sensitised photographic plate. The best photographs so far have been obtained from cultures containing spores. Radio-active organisms have given off photo-actinic emanations after three months have elapsed since their exposure to radium. Photographs of such bacterial masses have been obtained through a double layer of lead foil, but as the β rays were cut off by interposing greater thicknesses of lead the passage of photo-actinic rays to the sensitised film was prevented.

"Further Note on some Additional Points in Connection with Chloroformed Calf Vaccine." By Dr. Alan B. **Green.** Communicated by Dr. W. H. Power, C.B., F.R.S.

Since a former paper on this subject was read in April, 1903, the use within two weeks of their collection from the calf of a large number of vaccine lymphs prepared by the chloroform process has resulted in high "case" and "insertion" success.

The following further points in connection with these vaccines have been investigated:—

(1) The temperature at which vaccine water emulsion is

subjected to the chloroform process determines largely the rate at which the extraneous bacteria of that emulsion are eliminated. The temperature at which extraneous bacteria are killed most quickly, the specific germ being left meanwhile in a state of full activity, lies probably between 18° C. and 23° C.

(2) It has been found that several additional species of bacteria are rapidly eliminated from vaccine by means of the chloroform process:—*B. proteus vulgaris*, *B. prodigiosus*, *B. pyocyaneus*, *B. fluorescens liquefaciens*, *B. coli communis*, *B. typhosus*, *B. diphtheriae*, *B. mallei*, *B. pestis*, *B. tuberculosis* and *S. cholerae Asiaticae*. These bacteria were added artificially to vaccine collected for experiment only.

(3) The keeping properties of chloroformed vaccine have been investigated. Vaccines prepared by the chloroform process were stored for the same length of time as commonly elapses at these laboratories between the collection from the calf and use of lymphs prepared by glycerination—usually six weeks. The use of these stored chloroformed lymphs was attended with results of high "case" and "insertion" success.

Thus the further use of a large number of chloroformed vaccines confirms the conclusions arrived at in a former paper, and the important additional knowledge has been gained that chloroformed vaccine, if originally of sufficiently high potency, will, when prepared and stored under suitable conditions, retain potency in a high degree for a considerable time.

Linnean Society, May 5.—Prof. S. H. Vines, F.R.S., president, in the chair.—Colour and coloration in mammals and birds: J. L. **Bonhote.** In this the author brought forward further facts in support of the theory that the colour and coloration on animals are primarily due to physiological causes, and showing that where conditions of "high vigour" existed, the animals were as a rule deeply coloured. The second part of the paper dealt with the coloration, and examples were brought forward showing that before a moult the hair bleached along certain definite areas, and also that this bleaching was not a process continuing throughout the period between the moults, but confined as a rule to a few days or weeks immediately preceding the moult. Hence it was argued that both colour and coloration were primarily due to physiological causes, and that natural selection could only make use of those markings which were in the first place due to "vigour."—The cranial osteology of the fishes of the families Mormyridæ, Notopteridæ, and Hyodontidæ: Dr. **Ridewood.** Descriptions were given of the skulls of *Mormyrops deliciosus*, *Petrocephalus bane*, *Notopterus kapirat* and *Hyodon alosoides*, together with less complete accounts of those of Marcusenius, Gnathostomus, Hyperopisus, Mormyrus and Gymnarchus. As the result of a study of the skulls of these forms, Dr. Ridewood concludes that the families Mormyridæ, Notopteridæ and Hyodontidæ, though more closely related *inter se* than is either family with any other family of malacopterygian fishes, are not more intimately related with one another than was previously assumed to be the case.

Faraday Society, May 9.—Mr. Bertram Blount in the chair.—Studies in viscosity: Dr. C. E. **Fawsitt.** The paper referred to some relations of viscosity to salt formation and viscosity as an additive property.—The electrolytic oxidation of anthracine: Dr. F. M. **Perkin** and A. **Fontana.** The authors have taken up the study of the oxidation of anthracine primarily to ascertain whether it was possible to obtain a good laboratory method for the preparation of anthraquinone. The first attempts were made with solutions in acetone, platinum electrodes being employed. Although oxidation took place in solutions of anthracine in acetone, it was not found possible to oxidise more than about 55 per cent. of the anthracine. Attempts were then made to electrolyse anthracine suspended in 20 per cent. sulphuric acid, or in caustic alkali to which an oxygen carrier had been added. Various carriers were employed, the most satisfactory being chromium, cerium or manganese salts.

Geological Society, May 11.—Mr. H. B. Woodward, F.R.S., vice-president, in the chair.—On some quartzite-dykes in mountain-limestone near Snelston (Derbyshire): H. H. **Arnold-Bemrose.** The quartzite of these "dykes" consists of angular detritus, quartz-grains with enclosures, a few small grains of felspar, and a few shreds of mica. The grains are cemented by silica, and sometimes by calcite. The silica is present in the limestone in two forms, which have had an entirely different origin. An important bed of sandstone was found by sinking for a well at Marston Common Farm, and the same bed is found also about 800 feet south of the farm. The microscopic aspect of the rock is precisely similar to that of the dykes. It is at a period later than the Keuper that the silica which cemented the sandstone of the dykes and of the Common Farm appears to have been introduced.—Phenomena bearing upon the age of the Lake of Geneva: Dr. C. S. **Du Riche Preller.** The author has examined the low-level gravel-beds and other alluvia in the Rhone Valley. After describing the phenomena around the Lake of Geneva, and comparing them with those around the Lake of Zurich, he draws the following conclusions:—The low-level gravel-beds of the Rhone Valley near Geneva are fluviatile deposits of the second inter-Glacial period, and were formed before the present deep lake-basin. The high-level gravel-beds of La Côte above Rolle and of the Jorat district above Lausanne are true Deckenschotter. Hence the term "alluvion ancienne" should only apply to the high-level deposits. The formation of the present deep lake-basin of Geneva was primarily due to the lowering of the valley-floor by flexures of the Molasse and its contact-zones, posterior to the maximum glaciation. The author holds that the Lake of Geneva, together with the other principal zonal lakes between the Alps and the Jura, was formed under similar conditions and at the same time as the Lake of Zurich, that is, towards the close of the Glacial period.

Zoological Society, May 17.—Mr. Howard Saunders, vice-president, in the chair.—The fifth of a series of papers by Sir Charles **Eliot,** K.C.M.G., on Nudibranchs from Zanzibar and East Africa, was read. Twenty species were treated of in the paper, of which eleven were described as new.—Mr. G. A. **Boulenger,** F.R.S., described a new species of tree-frog of the genus Hyla, from British Guiana, carrying eggs on the back.—Mr. F. E. **Beddard,** F.R.S., read a paper containing notes on the anatomy of certain species of snakes of the family Boidæ.—A communication from Dr. G. Stewardson **Brady,** F.R.S., contained an account of a collection of Entomostraca made in Natal by Mr. James Gibson. Eleven species were enumerated in the paper, of which nine were described as new, one being made the type of a new genus.

Royal Microscopical Society, May 18.—Dr. Dukinfield H. Scott, F.R.S., president, in the chair.—A note by Mr. A. A. C. Eliot **Merlin** on Mr. Nelson's new formula amplifier was read. The amplifier, which consists of a negative lens placed in the rear of the objective, was calculated by Mr. Nelson at the request of the author to enable him to make some delicate microscopical measurements. With the usual arrangement of a low power eye-piece and screw micrometer, the magnification afforded by objectives of high power was insufficient to ensure accuracy in all cases, and it was not desirable to use more powerful eye-pieces, as the spider lines then appeared too coarse. The author found the amplifier yielded especially good results when used for micrometrical purposes, and he suggested the application of it to students' microscopes for quickly obtaining an increase of magnifying power. Mr. Nelson's formula for the amplifier was given.—A note on Grayson's 120,000 band plate by Mr. **Nelson** was then read. The band was resolved strongly by an apochromatic oil immersion 1/8, 1·43 N.A., and a 5 eye-piece; it was also resolved by a semi-apochromatic 1/10, 1·3 N.A., and a 5 eye-piece, and by an old achromatic water immersion 1/12, 1·2 N.A.; in this case the lines appeared to have irregularities. The 90,000 band was resolved by an apochromatic of 4 mm., 0·97 N.A., quite easily, and by a $\frac{1}{4}$ dry apochromatic $\frac{1}{4}$, 0·96 N.A., with some difficulty. The author remarked in passing that the latest books on physical optics state that 1/90,000 inch is the theoretical limit for microscopic vision. After giving particulars of the resolution of other bands, Mr. Nelson stated that ruled lines are more difficult to resolve than diatoms of equal fineness. He said

the best screen for work of this kind is made from a saturated solution of acetate of copper many times filtered, to which a very small quantity of methylene blue should be added. Sunlight with a heliostat was used, and the light made oblique in one azimuth. The theoretical resolving limit for oblique light may be *roughly* taken at 100,000 times the N.A. of the objective. Dr. Hebb said he saw this plate exhibited at the Royal Society's conversazione, and though it was certainly resolved, he remarked that some of the lines appeared weaker than others. Mr. E. E. Hill said this was due to the fact that the objective used had an aperture of only 1·1 N.A.

DUBLIN.

Royal Dublin Society, April 19.—Prof. E. J. McWeeney in the chair.—Mr. G. H. **Carpenter** read a paper on injurious insects, &c., observed in Ireland during the year 1903. The prevalence of the black-currant mite (*Eriophyes ribis*) in certain districts was mentioned, and attention was directed to the economic importance of some species of springtails (*e.g. Achorutes armatus* and *Lipura ambulans*) on account of their habit of attacking healthy seeds and fruits.—Prof. J. A. **McLelland** read a paper on the penetrating radium radiation. As the γ rays act in some ways more like charged particles than like Röntgen rays, the author has made experiments to test directly whether or not a charge is carried by the γ rays. No charge was detected. The sensitiveness of the apparatus is defined by showing how small a fraction of the β radiation could have been detected by means of the charge on the β particles. The second part of the paper deals with the absorption of γ rays by different substances, and it is shown that these rays are to some extent heterogeneous, and that the absorption-density law is followed with remarkable closeness when one deals only with the most penetrating of the γ rays.—Dr. W. E. **Adeney** made a further communication on photographs of spark-spectra from the 21·5 feet Rowland spectrometer in the Royal University, Dublin. In this paper the author deals with the wave-lengths of the lines in the ultra-violet spark-spectra of platinum and chromium. These have been calculated from measurements made from photographs of the first order of spectra, reproductions of which were published in the first part of this work (*Trans.* Roy. Dubl. Soc., vol. vii., 1901, p. 331). Kayser's measurements of well defined lines in the arc-spectrum of platinum have been employed as standards.—Prof. E. J. **McWeeney** read a paper on the cases of carbon-monoxide asphyxiation that have occurred in Dublin since the addition of carburetted water-gas to the ordinary coal-gas. Attention was first directed to the increase of carbon-monoxide in the Dublin coal-gas by Prof. Emerson Reynolds, F.R.S., in a paper read before the Royal Dublin Society in 1900 (*Scientific Proceed.*, vol. ix. p. 304). Analyses made for Prof. McWeeney by Mr. J. Holm Pollok showed 17·2, 16·8 and 14·6 per cent. of CO respectively. The author proceeded to recount in detail the circumstances attending seven fatal cases that had come under his notice during the past three years, each of which presented special features of interest. In one of the cases, which had a fatal termination, the hæmoglobin of the blood was saturated to the extent of 73 per cent. with carbon monoxide; in another the latter amounted to 87·7 per cent. The victim in this case, a young man, was asphyxiated in his bath by the CO-containing fumes escaping from a badly constructed and unventilated "geyser." The author concluded by emphasising the need for increased caution imposed by the more deadly nature of the gas now supplied.

PARIS.

Academy of Sciences, May 24.—M. Mascart in the chair.—On the limits of sensitiveness for odours and emanations: M. **Berthelot.** The rate of loss of musk and iodoform under certain conditions is compared with emanations from a small quantity of a foreign element mixed with a large quantity of an element not giving an emanation.—On γ-diphenylanthracene and on the hydride of symmetrical γ-diphenylanthracene: A. **Haller** and A. **Guyot.** Phenyloxanthranol reacts with phenyl-magnesium bromide, giving about 50 per cent. of the expected diol. The replacement of the phenyloxanthranol by its methyl ether in this reaction gives a nearly theoretical yield. This, on reduction with sodium amalgam, gives the dihydride of diphenylanthracene.—On some new facts observed by means of a phosphorescent screen: E. **Bichat.** The direct hydrogenation of the homologues of aniline: Paul **Sabatier** and J. B. **Senderens.** By passing a mixture of hydrogen and the vapours of the alkyl-anilines over reduced nickel at 160° C. to 180° C., cyclohexylethylamine, cyclohexyldiethylamine and cyclohexyldimethylaniline have been obtained, the physical properties of which are given. Cyclohexylmethylaniline was obtained with difficulty from methylaniline by this reaction.—The detonation under water of explosive substances: M. **Jacob.** The phenomena of propagation of the motion are completely different in the cases where the coefficient of compressibility is supposed constant and where it is taken as variable. In the first case, the speed of propagation of the motion is constant, in the latter it is variable, and increases with the pressure.—On the energy in the so-called statical actions, its relation with the quantity of motion and its differentiation from the work: Ernest **Solvay.**—The resistance of the air. The comparison of the direct resistances of different aërial vanes; numerical results: Ch. **Renard.** These results were obtained with the dynamometric balance previously described by the author, and prove the law of the square of the velocity to be exact. Numerical results are given for the coefficients of vanes of different shapes.—On an instrument designed to facilitate calculations in screw-cutting: M. **Mœhlenbruck.**—On the thermal ionisation of saline vapours: G. **Moreau.** A current of air drawn through a saline solution is heated in a porcelain tube to about 1000° C., and the conductivity measured. It was found that the ionisation of the potassium salts studied was not analogous to that observed in a flame, where the influence of the acid radical is very small. The mobilities of the ions also differ in the two cases.—The cryoscopic study of solutions of antimony sulphide: MM. **Guinchant** and **Chrétien.** The lowering of the melting point of pure antimony sulphide by varying quantities of lead and silver sulphides was determined by a thermocouple, the temperature being maintained by an electrical resistance furnace of nickel wire. The average cryoscopic constant found was 790. The value for the latent heat of fusion deduced by the application of van 't Hoff's formula was 16·7 calories; the value determined direct was found to be 17·5 calories. The experimental results obtained for the lowering of the melting point of antimony sulphide by metallic antimony are in accord with the view that the antimony is in the atomic condition.—The estimation of atmospheric formaldehyde: H. **Henriet.** The aldehyde is estimated by drawing the air over mercuric oxide mixed with glass wool at a temperature of 250° C., and estimating the carbon dioxide formed. The accuracy of the method was proved by blank experiments with known amounts of formaldehyde. The conclusion is drawn from these experiments that formaldehyde exists in the air in the proportion of from 2 to 6 grams per 100 cubic metres of air, this being very large compared with ozone, which is present to the extent of 2 or 3 milligrams in the same volume. The author proposes to make a study of its physiological action.—A method for the characterisation of the fatty acids: René **Locquin.** The sodium salt of the acid is treated in ethereal solution with monochloracetone, and the acetol ester thus produced transformed into its semicarbazone, the melting point of which is taken. The melting points of five semicarbazones derived from five fatty acids are given.—The transformation of ortho-azo-alcohols into indazyl derivatives: P. **Freundler.**—The limit of combination of diazobenzene and phenol: Léo **Vignon.**—The modifications of the radiations from the nervous centres under the action of anæsthetics: Jean **Becquerel** and André **Broca.** From the variations of the *n*-rays, as measured by the lustre of a phosphorescent screen, the action of the anæsthetic can be followed, the point when danger to life commences and the point of death being easily distinguished.—On a physical proof of the adaptation between natural reagents and their perceptive organs: Augustin **Charpentier.**—The action of the *n*-rays on biological phenomena: M. **Lambert** and Ed. **Meyer.**—On cases of rapid expulsion of calculi by d'Arsonvalisation: A. **Moutier.**—On the sterilisation of cork: F. **Bordas.** Superheated steam was found to give the best results.—Study of the

lypolytic action of the cytoplasma of the castor oil seed: Maurice **Nicloux.**—On the hydrolysing properties of the castor oil seed: Ed. **Urbain** and L. **Saugon.**—On the modifications of the ergographic constants under different experimental conditions: Mlle. I. **Ioteyko.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 2.

ROYAL SOCIETY, at 4.30.—On the Aurora Borealis and the Electric Charge of the Sun: Prof. Svante Arrhenius.—Colours in Metal Glasses and in Metallic Films: J. C. Maxwell Garnett.—On a Direct Method of Measuring the Coefficient of Volume-elasticity of Metals: A. Mallock, F.R.S.—A Method of Measuring Directly High Osmotic Pressures: The Earl of Berkeley and E. G. J. Hartley.—The Advancing Front of the Train of Waves Emitted by a Theoretical Hertzian Oscillator: Prof. A. E. H. Love, F.R.S.—On the General Circulation of the Atmosphere in Middle and Higher Latitudes: Dr. W. N. Shaw, F.R.S—On the Magnetic Changes of Length in Annealed Rods of Cobalt and Nickel: Dr. S. Bidwell, F.R.S.—On the Electric Effect of Rotating a Dielectric in a Magnetic Field: Dr H. A. Wilson.

LINNEAN SOCIETY, at 8.—The Species of Impatiens in the Wallichian Herbarium: Sir Jos. D. Hooker, G.C.S.I., F.R.S.—Biscayan Plankton. Part III. Chætognathia: Dr. G. H. Fowler.—The Flow of Fluids in Plant-stems: Prof. R. J. Anderson.

RÖNTGEN SOCIETY, at 8.30.—Experiments to Determine the Effects of Form and Winding upon Resonance Phenomena: Dr. Clarence A. Wright.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Suggestions respecting the Institution of Mining Engineers: Prof. R. A. S. Redmayne.—Coal-mining in the Faroe Islands: G. A. Greener.—Tin-mining in the Straits Settlements, with a few Notes regarding Chinese Labour: W. T. Saunders.—Underground Temperatures, especially with regard to Coal-mines: Dr. Hoefer.—The Hammer-Fennel Tachymeter-theodolite: A. O. Eoll.—Notes on the Report of the Departmental Committee on the Use of Electricity in Mines: Sydney F. Walker.—A Comparison of Three-phase and Continuous Currents for Mining Purposes: Roslyn Holiday.—Electric and Compressed-air Locomotives: B. S. Randolph.—Work of Conveyors on Longwall Faces: Robert G. Ware.

CHEMICAL SOCIETY, at 8.—*iso*Nitrosocamphor: M. O. Forster.—Imino-Ethers and Allied Compounds corresponding with the Substituted Oxamic Esters: G. D. Lander.—The Action of Heat on α-Hydroxycarboxylic Acids: Part I. α-Hydroxystearic Acid: H. R. Le Sueur.—The Basic Properties of Oxygen. Additive Derivatives of the Halogen Acids and Organic Compounds and the Higher Valencies of Oxygen. Asymmetric Oxygen: E. H. Archibald and D. McIntosh.

FRIDAY, JUNE 3.

ROYAL INSTITUTION, at 9.—The Development of the Theory of Electrolytic Dissociation: Prof. Svante Arrhenius.

INSTITUTION OF MINING ENGINEERS, at 10.30 a.m.—The Firing of Babcock Boilers with Coke-oven Gases: T. Y. Greener.—Explosives and Lamp Testing Station at Frameries: Victor Watteyne.—The Transvaal Kromdraai Conglomerates: A. R. Sawyer.—The Southern Rand Goldfield: A. R. Sawyer.—The Occurrence of Cinnabar in British Columbia: G. F. Monckton.—Prevention of Accidents in Winding: John H. Merivale.—Petroleum and its Use for Illumination, Lubricating and Fuel Purposes: P. Dvorkovitz.—The Analytical Valuation of Gas Coals: G. P. Lishman.—A New Process of Chlorination for Mixed Gold and Silver Ores: H. F. Brown.—Graphite-mining in Ceylon and India—Part I. Ceylon: G. A. Stonier.

GEOLOGISTS' ASSOCIATION, at 8.—The Geology and Prehistoric Anthropology of the Hastings District, with Special Reference to the Excursion of June 11: W. J. Lewis Abbott.

SATURDAY, JUNE 4.

ROYAL INSTITUTION, at 3.—Spitsbergen in the Seventeenth Century: Sir W. Martin Conway.

MONDAY, JUNE 6.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The loss of Nitre in the Chamber Process: J. K. H. Inglis.—Acetone—its Manufacture and Purification: A. Marshall.—A New Method for the Estimation of Tannin: J. Gordon Parker and E. E. M. Payne.

ARISTOTELIAN SOCIETY, at 8.—Primary and Secondary Qualities: Prof. G. F. Stout.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

TUESDAY, JUNE 7.

MINERALOGICAL SOCIETY, at 8.—On Cobaltiferous Mispickel from Norway: Rev. Mark Fletcher.—On an Improved Form of Refractometer: G. F. Herbert Smith.—Notes on the Development of the Kimberley Diamond Mines, with Lantern Illustrations: Prof. H. A. Miers, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—On some New or little-known Butterflies, mainly from High Elevations in the N.E. Himalayas: Lieut.-Col. J. Malcolm Fawcett.—On Seasonal Phases in Butterflies: Dr. A. G. Butler.—Note on an Apparently Abnormal Position of the "Brephos" within the Body of a Skink (*Chalcides lineatus*): F. E. Beddard, F.R.S.—On the Rare Rodent *Dinomys branickii*, Peters: Dr. E. A. Goeldi.—On the Black Wild Cat of Transcaucasia: C. Satunin.—On a Buffalo Skull from East Central Africa: R. Lydekker.—On Two New Labyrinthodont Skulls: Dr. A. Smith Woodward, F.R.S.

WEDNESDAY, JUNE 8.

GEOLOGICAL SOCIETY, at 8.—The Palæontological Sequence in the Carboniferous Limestone of the Bristol Area: A. Vaughan.—The Evidence for a Non-Sequence between the Keuper and Rhætic Series in North-west Gloucestershire and Worcestershire: L. Richardson.—On a Small Plesiosaurus-Skeleton from the White Lias of Westbury-on-Severn: W. F. Gwinnell.

VICTORIA INSTITUTE, at 4.30.—Annual Meeting. The President, the Lord Chancellor, F.R.S., will deliver the annual address.

THURSDAY, JUNE 9.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—On the Ossiferous Cave-Deposits of Cyprus, with Descriptions of the Remains of *Elephas cypriotes*: Miss D. M. A. Bate.—On the Structure and Affinities of Palæodiscus and Agelacrinus: W. K. Spencer.—On the Physical Relation of Chloroform to Blood: Dr. A. D. Waller, F.R.S.—Contributions to the Study of the Action of Sea-Snake Venoms: Sir Thomas R. Fraser, F.R.S., and Major R. H. Elliot, I.M.S.—On the Action of the Venom of *Bungarus coeruleus* (the Common Krait): Major R. H. Elliot, I.M.S., W. C. Sillar and G. S. Carmichael.—On the Combining Properties of Serum-Complements and on Complementoids: Prof. R. Muir and C. H. Browning.—Notes on the Statolith Theory of Geotropism: F. Darwin, For.Sec.R.S., and D. F. M. Pertz.

MATHEMATICAL SOCIETY, at 5.30.—The Application of Poisson's Formula to Discontinuous Disturbances: Lord Rayleigh.—Some Expansions for the Periods of the Jacobian Elliptic Functions: H. Bateman.—Types of Covariants of any Degree in the Coefficients of Each of Any Number of Binary Quantics: P. W. Wood.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.—Annual General Meeting.

FRIDAY, JUNE 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.—On *Damayantia smithi*, Godwin-Austen and Collinge: Lt.-Col. H. H. Godwin-Austen.—Descriptions of Twenty-nine Species of Gastropoda from the Persian Gulf, Gulf of Oman, and Arabian Sea, dredged by Mr. F. W. Townsend, 1903-4: J. Cosmo Melvill.—*Conus Coromandelicus*, Sm, its Probable Affinities and Systematic place in the family Conidæ: J. Cosmo Melvill.—Descriptions of New Marine Shells from the Collection of the late Admiral Keppel: G. B. Sowerby.—Note on *Voluta brazieri*, Cox: E. A. Smith, I.S.O.—On *Doris planata* of Alder and Hancock: Sir C. Eliot, K.C.M.G.—Description of a Helicoid Land Shell from Central Australia: J. H. Ponsonby.—On Some Semi-fossil Land Shells found in the Hamakua District, Hawaii: C. F. Ancey.

CONTENTS.

THURSDAY, JUNE 9, 1904.

AN AMERICAN TREATISE ON NAVAL ARCHITECTURE.

Naval Architecture. By Prof. C. H. Peabody. Pp. v+616. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 31*s.* 6*d.* net.

SINCE the revival of shipbuilding in the United States and the construction of the "New Navy," courses of instruction in naval architecture have been arranged at several of the universities and technical institutes. The Massachusetts Institute of Technology has taken a leading position in this matter, and has provided classes for those intending to enter the profession of shipbuilding, as well as a post-graduate course in naval architecture especially arranged for assistant constructors whose preliminary training is at the Naval College, Annapolis. For many years the Navy Department of the United States had to send their assistant constructors to Europe for instruction. The first students who so came were entered at the Royal Naval College at Greenwich; in later years many young American naval architects have been students at Glasgow University. Others have been sent to the French School of Naval Architecture. For the future, it would appear that the United States intend to supply their own educational wants in this as in other branches.

The author of the book under review is the professor of naval architecture and marine engineering in the Massachusetts Institute of Technology, and it is obvious that the book has grown largely out of his professorial work. It is also apparent that Prof. Peabody has considerable sympathy with French methods. Indeed, he adopts several French technical terms instead of their usual English equivalents, and in certain sections of the book he gives prominence to French methods as distinguished from English. While this comprehensive treatment is praiseworthy, no sufficient reason is seen for departure from the accepted terminology of English treatises on the subject.

The book is intended "to give, in a consistent and connected form, the commonly accepted theory of Naval Architecture," and it is added, "while this work is intended primarily for students, it is hoped that it may be found useful by Naval Architects and Shipbuilders in general." It is probable that this hope will be realised, so far as those sections of the book are concerned which deal with ordinary ship calculations for displacement and stability, or those illustrating many practical operations connected with the addition, removal, or transfer of weights carried by ships. Herein Prof. Peabody bases his treatment upon the frank adoption, in practice, of mechanical aids to calculation which have been introduced during the last twenty-five years, chiefly by Amsler. Naval architects owe much to that great instrument maker, and can effect with his integrators an enormous economy of labour and a great increase of speed in obtaining important results. The planimeter for many years stood alone, but when Amsler learned that, in addition to the determination of areas, it was important in the designing of ships to obtain also *moments,* and *moments of inertia,* of areas about assigned axes, he speedily produced ingenious machines which could be used by ordinary draughtsmen. These instruments were first adopted in this country, and are now generally employed.

Prof. Peabody gives a clear account of the principles and methods of use of integrators. Moreover, he furnishes an excellent summary of the latest modes of arranging the actual details of work for ships' calculations. In this department very considerable advances have been made during the last thirty years since calculations for the stability of ships became general. But while, from the draughtsman's point of view, the book is, for the most part, admirable, it does not treat with equal fulness some calculations of considerable importance, particularly those relating to weight and strength. For these his treatment can hardly be described as "up to date," or as giving full and complete information to students or calculators. There is, in fact, a want of due proportion in the space and attention devoted to the various sections. Prof. Peabody, while aiming at giving a consistent and connected account of the whole accepted theory of naval architecture, devotes particular attention to certain portions of the subject, and unduly compresses his treatment of others. Some of his longest chapters, while they are undoubtedly interesting and valuable as compilations of existing treatises on special branches of the science of shipbuilding, have not, as a matter of fact, great practical value. The theory of waves, for example, including an outline of the stream-line theory of resistance, occupies nearly one-eighth of the book, and is treated in some portions with a mathematical detail that appears inappropriate in this work, where the principal conclusions might have been given and reference made to the original authorities for the mathematical proofs.

Again, in dealing with the propulsion of ships, much space is devoted to the practical reproduction of parts of well known books dealing with the design and efficiency of screw-propellers, such as that published in England by Mr. Sidney Barnaby, and that first issued in the United States by Naval Constructor Taylor, who was a graduate of our Royal Naval College. Both these gentlemen based their work chiefly on experiments made, or on methods suggested, by the late Mr. William Froude and Mr. R. E. Froude, and furnished valuable rules for guidance in practice; but as their books are accessible, they need not have been so largely drawn upon. Having done this, Prof. Peabody was practically compelled to abridge very greatly his treatment of other sections of great importance in the current work of ship designing, wherein students might have been greatly assisted if more extended descriptions and investigations had been given.

Another feature in which the volume is not entirely satisfactory is in some of its illustrations of actual practice, and in its allusion to broad general rules

followed by naval architects in endeavouring to secure good qualities in ships. For instance, Prof. Peabody, when dealing with the question of "metacentric heights," which are the measures of the "stiffness" of ships, their power to resist inclination under the action of external forces, states that, in practice, this height "is seldom less than $1\frac{1}{2}$ feet and seldom more than 5 feet unless it be in special forms," and then remarks that "it appears that the metacentric height for steamships is somewhere near the same for all steamships whatever their size," which is obviously incorrect on his own showing, and might easily lead students to conclude that little importance attaches to the value of the metacentric height within a very wide range; whereas it is absolutely certain, and is elsewhere recognised by Prof. Peabody, that the more moderate the metacentric height the greater is the probability of steadiness in a seaway. He also states that "metacentric height may be controlled by varying the proportion of beam to length," and does not specifically direct attention to the much greater influence of variation in the proportion of beam to draught.

In another passage he refers to the characteristic features in the curves of stability of sailing ships and steamships, and makes the generalisation that this is chiefly due to the greater metacentric height and greater freeboard of sailing ships; whereas it is perfectly well known that other considerations have larger practical effect on the curve of stability. Many sailing ships having great range of stability have only very moderate metacentric heights and moderate freeboard. Few allusions are made to the details of practical shipbuilding, and some of these indicate that the author can have had but little experience in the conduct of actual work.

These criticisms are not intended to indicate any general disapproval of the scope or character of the book. It is no doubt intended to be used as an auxiliary to class-teaching by competent professors, and for this purpose it will be extremely useful. It also compiles and brings together much information appearing in the *Transactions* of the English Institution of Naval Architects or of similar societies in other countries, and practically reproduces the essential parts of standard treatises by other authors on particular branches of the subject. Prof. Peabody makes no claim to originality, and states frankly that free use has been made of numerous works on naval architecture, as well as of original articles and memoirs. His readers have to thank him for the labour he has bestowed upon this task, and, as a compilation, the book will be useful for reference to naval architects generally. But it does not profess to be—nor, indeed, within its compass could it possibly be made—a complete treatise on the modern theory of naval architecture. Such a treatise has yet to be written, and the advances made in recent years in both the theory and practice of ship construction have been so considerable that the work of preparing it would be very heavy. It is wanted, however, and no doubt will eventually be produced.

W. H. White.

NEW ELECTRICAL TEXT-BOOKS.

A Text-book of Static Electricity. By H. Mason. Pp. vi+155. (New York: McGraw Publishing Co., 1904.) Price 2 dollars.

Dynamo, Motor, and Switchboard Circuits. By W. R. Bowker. Pp. xi+120. (London: Crosby Lockwood and Son, 1904.) Price 6*s*. net.

Testing of Electromagnetic Machinery and Other Apparatus. By B. V. Swenson and B. Frankenfield. Pp. xxiii+420. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1904.) Price 12*s*. 6*d*. net.

The Alternating Current Transformer. By F. G. Baum. Pp. vii+195. (New York: McGraw Publishing Co., 1903.) Price 1.50 dollars.

The Induction Motor. By H. B. de la Tour. Translated by C. O. Mailloux. Pp. xxvii+200. (New York: McGraw Publishing Co., 1903.) Price 2.50 dollars.

The subject of electrostatics is not *per se* one of very great importance either to the electrical engineer or the student of electricity, and it is open to question whether a text-book devoted to the elementary principles of the subject is much needed. Still, there is something to be said for having collected together between one pair of covers all the information which is usually only to be found scattered somewhat irregularly throughout the pages of a more comprehensive manual. Mr. Mason opens with a discussion of the general principles of electrostatics, and proceeds to consider in more detail capacity, electrostatic instruments, and static generators. The fact that there is not very much to say and plenty of space in which to say it has enabled the author to make his descriptions very complete and clear, and the further advantages of large type and numerous illustrations should help to make the book a very useful work of reference.

Mr. Bowker's book consists chiefly of diagrams of connections, with short explanatory notes: the number of different cases considered is very large—there are over a hundred diagrams—and these cover practically all the more important circuits with which an electrician is likely to have to deal, whether in direct current, single phase, or polyphase work. We do not doubt that the book will prove useful to those who are concerned rather with connecting up machinery than with electrical engineering, but we should hardly have thought that the matter was of sufficient importance to warrant its treatment as a separate study.

The work on the testing of electromagnetic machinery by Messrs. Swenson and Frankenfield is the first of two volumes, and deals only with direct-current machinery. It is a book which can be thoroughly recommended to all students of electrical engineering who are interested in the design, manufacture, or use of dynamos and motors. After a brief introduction, which contains, incidentally, some excellent advice on the writing of reports (which advice, by the way, the authors themselves transgress in the specimen report which they print), the authors give a series of nearly a hundred tests, which are well chosen and

clearly explained. A distinct and valuable feature of the book is the list of references at the beginning of each test to the principal text-books and papers dealing with the subject of the test. The book is well illustrated, and there is a useful chapter at the end on commercial shop tests.

The two books by Mr. Baum and M. de la Tour cover, in a satisfactory manner, two very important branches of alternating-current work on which not very much has yet been written in the way of text-books. This is especially the case with M. de la Tour's treatise on the induction motor, which is very comprehensive and certainly the best book as yet written on this subject. Mr. Baum's book is not so full, but it contains an excellent discussion of the theory and construction of transformers, which should prove very useful to students. It is difficult to understand why chapter ii. has been included at all, since the method given in it is not only unsatisfactory but, even in the author's own opinion, "always produces confusion in the mind of the student." There is a good final chapter on commercial transformers. M. de la Tour also leavens his theory with a little practical application of it, the last chapter but one being devoted to the design in very careful detail of three different induction motors. A word of praise is also deserved by the translator for the excellent way in which he has performed his task of presenting M. de la Tour's book to the English public.

M. S.

FROM BUFFON TO DARWIN.

Controverses Transformistes. By Alfred Giard. Pp. viii + 178. (Paris: C. Naud, 1904.) Price 7 francs.

THIS is an interesting book, written, like nearly all French scientific books, in transparently clear style. It assumes, however, that the reader has a fair knowledge of zoology, so that it hardly appeals to the reading world in general. It is intended rather for those who have made some study of comparative anatomy, and who wish for light on the various theories of evolution. In France Darwinism has not had the triumphant progress that it has had in England and, still more, in Germany. Even evolution, quite apart from the specially Darwinian interpretation of it, has been very slowly accepted, so that the earlier part of M. Giard's book deals with controversies that for us have long been buried. The second chapter, which originally appeared as an article in the *Revue scientifique* in 1874, discusses at length the question whether the ascidians are really near allies of the vertebrates. A figure of the larva of a typical ascidian is given, but it would have been well to give also a figure of Appendicularia, in which the notochord persists in the adult. Throughout, the book would have gained by being more amply illustrated. The chapter on ascidians combats von Baer's now exploded theory of them, perhaps at rather unnecessary length. But the author has deliberately adopted the plan of reprinting his essays written during the last quarter of the nineteenth century so that the reader may appreciate the difficulties against which the evolutionist has had to contend.

Chapter iii. deals with systems of classification that have had their day, systems which accepted each type of organism as an existing fact without attempting to account for it. M. Giard is heart and soul an embryologist. Kowalevsky is to him a far greater man than the greatest master of anatomy pure and simple who has had no grand hypothesis to guide him.

In chapter iv., on the factors of evolution, we enter on more controversial ground. M. Giard is a Lamarckian. He has a great reverence for Darwin, but Lamarck is put on a loftier pedestal. Lamarck, he holds, made known the great primary factor of evolution. Darwin introduced an important factor, but still a secondary one. In some cases M. Giard owns that the Lamarckian principle will not account for everything, *e.g.* for all the characters of a newborn mammal. Darwinism must then be called in. In chapter v. (1898) Weismann appears as a conspicuous figure on the stage. M. Giard will not allow Weismann to send Lamarckism to the limbo of worn out theories. He refers to the experiments of Brown-Séquard on guinea-pigs as proof that Lamarck was right. He accepts telegony as a fact telling strongly in Lamarck's favour, though men of science are coming to regard it as a breeder's superstition. Throughout his discussion of the question of acquired characteristics there is a certain confusion of thought. He draws a marked distinction between the characters that result from external conditions and those which spring from forces at work within the animal. Yet external influences can only stimulate the organism to show the stuff that it is made of. It responds to a stimulus. New characters become apparent, but are not, strictly speaking, acquired.

F. W. H.

OUR BOOK SHELF.

A Text-book of Quantitative Chemical Analysis. By Frank Julian. Pp. 604. (St. Paul, Minn.: The Ramsey Publishing Co., 1902.) Price 25*s.* net.

THE book is so excellent as far as it goes, except in the quality of the paper and the print, that it seems a pity it goes no farther. A little more elaboration would have converted it into a really serviceable manual. The reviewer has failed to discover any important omission among the special methods with which he happens to be familiar, but there is an absence of detail, which, it cannot be too often insisted on, deprives any treatise on analysis of much of its practical value. The chemist whose business it is to analyse cannot afford the time to elaborate methods for himself. The fact, of course, is not overlooked that the book is written for students, and no doubt the student is expected to supply any gaps which may occur. But apart from a chapter of typical exercises in analysis, it is difficult to see in what sense the book can be called a student's text-book, unless, indeed, the student is qualifying for the post of analyst.

And this raises the interesting question, into which there is no occasion to enter here, of how far analysis should be carried as a part of a general chemical training as distinguished from a specialised study. There can be little doubt that the kind of skill and knowledge which a public or works analyst requires must be met by a special training in a laboratory set apart for the purpose.

What a student of general chemistry needs, after

his preliminary qualitative study of the elements, is a knowledge of a few typical processes carefully selected to illustrate the principles of quantitative analysis.

It is for this reason that the exercises which form part ii. of this volume have much to recommend them. Those who are accustomed to the old system, which probably originated in Berzelius's laboratory, of analysing a few inorganic salts and then a series of minerals, will probably be startled at finding such an incongruous collection as lead carbonate, sodium chloride, coffee, cast iron, vinegar, &c., following one another. Yet when one considers how few students, after taking a substantial course in practical chemistry, could suggest a means for distinguishing between lard and vaseline, or benzene and petroleum, except by their smell, it must be admitted that a practical acquaintance with common materials in the form of analysis has many advantages.

Perhaps the best way of estimating the value of a book is to ask oneself whether one would care to possess it For those who are interested in any kind of general or technical analysis, this question may be safely answered in the affirmative. J. B. C.

Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Natural History). The Jurassic Flora. II. Liassic and Oolitic Floras of England (excluding the Inferior Oolite Plants of the Yorkshire Coast). By A. C. Seward, F.R.S. Pp. xv + 192. Plates i–xiii. (London: Printed by Order of the Trustees of the British Museum, 1904.)

The concluding part of Mr. Seward's catalogue of the Jurassic floras makes the catalogue a nearly complete treatise on the known fossil remains of plants from the Trias, Rhætic, Lias and Oolite of England. In the present volume are included plants from Jurassic rocks in various parts of England, together with a few from the Coralline Oolite and Liassic strata of East Yorkshire. A short account is also given of such Triassic and Rhætic plants as are represented in the British Museum.

Die Kathodenstrahlen. By G. C. Schmidt. Pp. vi + 120. (Brunswick: Vieweg und Sohn, 1904.) Price 3 marks.

This book contains a concise and complete account of the properties of kathode rays, presented in an elementary way, together with as much information on the electric discharge and allied phenomena as is necessary for their comprehension.

The information is brought well up to date and references to the original papers are given. The book should prove of use to those wishing for a connected account of the subject in a readable form devoid of mathematical analysis. The fifth chapter contains a short but interesting account of the historical development of the theory of the electric discharge and kathode rays. H. A. W.

An Introduction to Metal Working. By C. J. Pearson. Pp. 106. (London: Murray, 1904.) Price 2s.

This little book is evidently intended to describe the ordinary tools used in the working of metals, although the author does not tell us so. These descriptions are of an elementary nature, and well suited for young students in the early stage. The book is fully illustrated with woodcuts, as well as with some very excellent photographs of operations, the latter being a distinct novelty in a technical book. The author uses simple language, he knows what he is writing about, and we feel sure that his little work will be much appreciated by junior students, apprentices and others, to whom we strongly recommend it.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

A Dynamical System illustrating the Spectrum Lines.

In Nature of March 10, which I received yesterday, Prof. Schott remarks that the dynamical system illustrating the spectrum lines, which I communicated to Nature of February 25, is unstable. This evidently rests on a misunderstanding, because the system which I have discussed is not identical with that which was investigated by Prof. Schott. I believe that the statement, "such an ideal atom will not be contradictory to the results of recent experiments," led Prof. Schott to suppose that the system which I considered must be electrically neutral. Those who have read Maxwell's paper on the stability of Saturn's rings will admit, without Prof. Schott's comment, the futility of discussing an *electrically neutral* system with a central positive charge and a ring of negative electrons as satellites.

The system which I have investigated is not electrically neutral, but the central charge is supposed to be very large compared with the negative charges in the ring. Since q (using Prof. Schott's notation) is great compared with J or K, the ring is generally stable; the proof for stability can be given in a more general manner.

To prevent further misunderstanding, it will be necessary to explain how I was led to investigate such a system instead of an electrically neutral one. As the principal aim of the investigation was to discuss the small oscillations which will illustrate the regularity in line and band spectra, it was necessary to have a hypothetical atom, which will have some resemblance to an actual one, and the motion of which can be treated by means of simple mathematical analysis. Recent investigations show that a chemical atom is associated with numerous electrons, which in the lightest element amount to several hundred, while in heavy atoms the number may reach a hundred thousand. We have reason to believe that these electrons are not crowded together in spite of their large number. In making abstraction as to the hypothetical atom, we may conveniently assume the central positive charge to form a neutral system with all the negative electrons, but only a small fraction of the latter to be found in the ring the oscillation of which is the subject of investigation. The rest of the negative electrons may either describe their isolated orbits, or may form some other regular systems. These will evidently cause disturbances in the ring, which I have not calculated, inasmuch as it was necessary to introduce further assumptions as to the orbits or the arrangement of electrons. As a dynamical system illustrating the regularity in spectrum lines, I have assumed the ring and the central positive charge as an ideal atom, leaving the remaining electrons outside the domain of investigation.

Further evidence as to the validity of such an hypothesis is afforded by the fact that spectrum lines of most elements are not all subject to a regular law, but that there are a great many characteristic lines the position of which is not expressible by a simple mathematical formula. Moreover, the complexity in the structure of spectrum lines will probably find simple explanation by the perturbations due to stray electrons. These considerations point to the view that only a small part of the negative electrons accompanying an atom should be arranged in a ring, in order to approximate to the real state of a chemical atom.

There is no doubt that Prof. Schott will have good opportunity of applying the mathematical investigations of C. Neumann and Hicks in discussing the oscillations of three rings, just as Lindemann made use of Lamé's functions in studying the spectrum lines as due to the vibration of ellipsoidal atoms, but I am afraid that the result will be difficult of interpretation.

I take this opportunity of introducing a small omission in my former letter to Nature for February 25 (p. 392, second column, line 31 from bottom); after "in opposite senses" add "in a magnetic field."

I may further add that the formula for band spectrum,

$$n' = \omega' + a'm'^2 + b'm'^3 + c'm'^4 + d'm'^5 + \ldots$$

which I have deduced as an extension of Deslandre's formula, is one of the empirical formulæ used by Kayser and Runge for cyanogen bands (*Abhandl. d. Berlin. Akad. d. Wissensch.*, 1889, formula I_a). From $m' = 0$ to $m' = 150$, the difference in wave-lengths between calculation and observation seldom exceeds $\pm 0 \cdot 03 \times 10^{-10}$ m., which is quite within errors of observation. H. NAGAOKA.

Physical Laboratory, Tokyo University, April 20.

Electromotive Force between Two Phases of the same Metal.

I WAS much interested in the letter of Mr. George Beilby in your issue of May 12. It may interest Mr. Beilby to know that I contributed a paper to the Institution of Civil Engineers on "The Effect of Stress on the Corrosion of Metals" (*Proc.* Inst. C.E., vol. cxviii., session 1893–4). On perusing this paper it will be seen that the results were somewhat analogous to the line of investigation Mr. Beilby is undertaking. The experiments were on an extensive scale, and were made on numerous samples of iron and steel. In each case a polished bar of the steel or other metal, of known chemical composition and physical properties, used was cut in two; one half was stressed, and the other remained in its normal state. Each pair of bars was immersed in sea water, as an electrolyte, forming the elements of a galvanic couple, with a delicate calibrated galvanometer in circuit, when a decidedly measurable E.M.F. was observed. It was invariably noticed that the alteration in the physical properties of the metals produced by the stress only in each stressed bar was sufficient to place that bar in the position of copper in a zinc copper cell, the normal unstressed bar answering to the zinc element in a galvanic couple.

A current is also set up between two polished bars of the same metal immersed in a suitable electrolyte, one being in its normal state and the other having had its microcrystalline structure altered by annealing, in the manner illustrated in a recent paper to the Institution of Civil Engineers ("Effects of Annealing on Steel Rails," by Thomas Andrews and Charles Reginald Andrews, *Proc.* Inst. C.E., vol. clvi., session 1903–4, part ii.). When a metal is stressed a similar effect is produced. I have for some time past been working on a research on the E.M.F. between normal and annealed metals, using in one part of the investigation a complete series of specially prepared pure iron and steel bars of varied and known chemical composition, the object of the investigation being to show the E.M.F. produced between annealed and unannealed metals. I am much pleased to learn that Mr. Beilby is also working on this very interesting subject.

Mr. Beilby may also be interested in a research which I made some years ago showing the E.M.F. produced between polished bars of platinum or other metals, cut from the same bar, the E.M.F. being attributable to difference of molecular structure induced by heating one of the bars. The electrolytes employed for these experiments were fused salts at a high temperature (see "Electrochemical Reactions between Metals in Fused Salts," by Thomas Andrews, *Trans.* Royal Society, Edinburgh, session 1885–6). I venture to suggest that the following papers ("Observations on Variations of the Electromotive Force between Metals at High Temperatures in Fused Salts," *Trans.* Royal Society, London, 1885; "Electrochemical Effects on Magnetising Iron," parts i., ii., iii., iv., *Trans.* Royal Society, London, 1887, 1888, 1889, 1892), which I published some time ago, may perhaps be helpful to Mr. Beilby in the course of his researches, the results of which I am looking forward to with much interest and pleasure. THOS. ANDREWS.

Wortley, near Sheffield, June 3.

Graphic Methods in an Educational Course in Mechanics.

IN company, I think, with other correspondents, I have misunderstood Mr. Larden's use of the words "analytical methods." He alluded, it is true, to resolution and taking moments, but "analytical methods," especially when used in contradistinction to "graphical," have a much wider and more commonly received meaning. Dr. Murray's dictionary defines modern mathematical analysis as "the resolving of problems by reducing them to equations," and cites Hutton, "Course Math.," 1827, "Analysis or Analytical method is that which is commonly used in Algebra." Prof. Croom Robertson, in "Analysis" in the "Ency. Brit.," says:—"In modern times analysis has come to mean the employment of the algebraical and higher calculus, and synthesis any direct treatment of the properties of geometrical figures, in the manner of the ancients without the use of algebraical notation or transformations." "Analytical" is a hard-worked word, like potential and polarisation, and no doubt it may be used in Mr. Larden's sense. The word "analytical," in the sense of the employment of algebra and the higher calculus, is not self-explanatory, and "graphical" or "geometrical" are better for this reason than "synthetical," unless the philosophical aspect is under discussion.

There can be no question that for almost all mathematical calculation and research, algebraical methods are far more powerful than geometrical (but I make reservations), and teachers are perhaps for this reason apt to think that they are more useful and better suited for educational explanations of phenomena or of natural laws. If in mistaking Mr. Larden for an unusually pronounced teacher of this type I have protested too strongly, I apologise, but his parenthetical queries which I have provoked I deny.

That some persons have accurate musical "ears," and others "no ear for music," that some can draw excellently without having been taught, and others can never learn, may perhaps be explained by physiological psychology. Some are "good at languages," and others bad; some have a "good head for figures," and others not. Experts in pedagogy might be able to tell us whether this is due to some selective ability or inability. But that some persons use algebra and the calculus with facility, and are bored by geometry, while others have "no head for algebra," but have an aptitude for geometrical methods, seems to be a matter worthy of investigation by the mental philosopher.

Not only has Mr. Larden used "analytical" in a somewhat restricted sense, but in this discussion he limits "graphic methods" to "those methods that depend on accurate drawing only, there being no calculation. . . ." I will give one example of what I mean by a graphical method in an educational course. The fundamental idea of a differential coefficient is explained in the old text-books purely by symbols. Persons with "no head for algebra" find the greatest difficulty in grasping the idea. But draw a curve of speeds on the black-board, and explain that a tangent to it, or the slope at any point, gives the acceleration or rate of increase. You need no accurate drawing, no calculation, no algebra, but you give a perfectly clear idea of a differential coefficient.

It is rather hard that those who are called calculus dodgers cannot discuss the relative advantages of algebraical and geometrical methods without being accused of writing against mathematics or deprecatingly of mathematicians.

Westminster, June 6. A. P. TROTTER.

Association of Economic Biologists.

FOR some time past workers engaged upon various problems connected with economic biology have felt the need of some organisation whereby they could meet from time to time to discuss these different problems with fellow-workers so as to bring out suggestions and to prevent unnecessary duplication of work, and generally to promote and advance the economic side of biological science.

With a view to the formation of such an association of economic biologists, I have briefly discussed the matter with a few fellow-workers, and I shall be pleased to receive an expression of opinion or suggestions from any others.

The idea at present in my mind is an association somewhat on the lines of the American one, which would include and welcome all investigators and teachers in economic biology in its widest sense.

Mr. Fred. V. Theobald (Wye) writes:—"Your suggestion for an Association of Economic Biologists is most excellent.

. . . I will certainly do all I can to promote any such idea."

Mr. Robert Newstead (Chester) writes:—"You would have my heartiest support in the matter, as I feel that such an institution would be of material benefit to the Agriculturists and Horticulturists of this country."

Mr. A. E. Shipley (Cambridge) writes:—"I should welcome the founding of an Association of Economic Biologists if you think we are really strong enough. . . . If the Association is formed I hope it will be a really working one."

Mr. Cecil Warburton (Cambridge) writes:—"I heartily approve of your suggestion with regard to the formation of an Association of Economic Biologists in this country."

Similar letters or expressions of opinion have been received from Dr. A. H. R. Buller, Mr. Herbert Stone, and others.

Walter E. Collinge.

The University, Birmingham, May 30.

THE RELATION OF HUMAN TO BOVINE TUBERCULOSIS.

The Royal Commission appointed to inquire into the relation of human and animal tuberculosis has presented an interim report published on June 1. The Commission was appointed in August, 1901, soon after Prof. Koch's address had been delivered at the British Congress on Tuberculosis held in London in July, 1901, in which he stated that as the result of experiments on animals, cattle, pigs, asses, sheep, and goats, he "felt justified in maintaining that human tuberculosis differs from bovine tuberculosis, and cannot be transmitted to cattle," and he also stated that "though the important question whether man is susceptible to bovine tuberculosis at all is not yet absolutely decided, and will not admit of absolute decision to-day or to-morrow, one is, nevertheless, at liberty to say that, if such a susceptibility really exists, the infection of human beings is but of very rare occurrence. I should estimate the extent of the infection by the milk and flesh of tuberculous cattle and the butter made of their milk as hardly greater than that of hereditary transmission, and I, therefore, do not deem it advisable to take any measures against it." According to Koch the chief danger of infection is from human tuberculous sputum. He suggested as the most important means of combating the disease the improvement of general hygienic conditions, provision of suitable hospitals and sanatoria for consumptives, and inspection and disinfection.

Lord Lister, at the conclusion of Prof. Koch's address, struck a note of warning. He pointed out "how serious and grievous a thing it would be if the rules now in force for securing purity of milk supply should be relaxed, and it should turn out after all that the conclusion was erroneous." This attitude was taken up by a number of other leading pathologists. Since Koch's statement a number of workers have published the results of experiments on the subject, and the bulk of the evidence has been opposed to Koch's view.

The most striking and interesting pronouncement on the subject has been from one of Koch's most distinguished pupils, von Behring, who on this subject places himself in a position entirely opposed to that of his old master. To many minds von Behring's view appears to be as extreme as Koch's. He holds that "the main source to which phthisis must be traced is the milk diet of infants." He found that in young animals such as guinea pigs, owing to the incomplete continuity of the epithelium, numerous bacilli, and among them the tubercle bacillus, could pass through the wall of the alimentary canal, giving rise to a tuberculosis of the cervical glands of the type of scrofula in the human subject, and that at a later period these animals not infrequently developed a type of tuberculosis which has been regarded as indicative of inhalation tuberculosis. The freedom with which milk-bacilli find their way through the walls of the alimentary tract into the circulation owing to the incomplete continuity of the epithelium and absence of active ferment secretion in young animals makes "the disposition to tuberculous infection entirely physiological and normal." At a later period in life a similar susceptible state may be induced by the exanthemata such as scarlet fever and measles. Von Behring, along with Römer, has also shown that immunity may be conferred on bovines by injection of tubercle bacilli of human origin, a striking argument in favour of the specific relationship of the two types of bacilli. These views, which have appeared since the appointment of the Commission, have only emphasised the need of further investigation.

The commissioners state that they felt it their duty to publish this interim report because the experimental results obtained by them are so striking.

The Commission was to inquire and report with respect to tuberculosis:—

(1) Whether the disease in animals and man is one and the same.

(2) Whether animals and man can be reciprocally infected with it.

(3) Under what conditions, if at all, the transmission of the disease from animals to man takes place, and what are the circumstances, favourable or unfavourable, to such transmission.

The first line of inquiry upon which the Commission entered was to ascertain the effects produced by introducing into the body of the bovine animal, either through the alimentary canal as food or directly into the tissues by subcutaneous or other injection, tuberculous material of human origin, that is, material containing living tubercle bacilli obtained from various cases of tuberculous disease in human beings, and how far these effects resembled or differed from the effects produced by introducing into the bovine animal under conditions as similar as possible tuberculous material of bovine origin, that is, material containing living tubercle bacilli obtained from cases of tuberculous disease in the cow, calf, or ox. More than twenty strains of tubercle bacilli have been employed, that is to say, the material taken from more than twenty cases of tuberculous disease in human beings. The effects produced were compared with those resulting from the injection of different strains of tuberculous material of bovine origin. In the case of seven of the above strains of human origin the injection of the human tuberculous material into cattle gave rise at once to acute tuberculosis, with the development of widespread disease in various organs of the body. In some instances the disease was of remarkable severity. In the case of the remaining strains the effects were less marked. The tuberculous disease was either limited to the spot where the material was introduced (this occurred, however, in two instances only, and these at the very beginning of their inquiry), or spread to a variable extent from the site of inoculation along the lymphatic glands with, at most, the appearance of a very small amount of tubercle in such organs as the lungs and spleen. Material, however, taken from the bovine animal thus affected and introduced into other bovine animals has, up to the present, in the case of at least five of these remaining strains, ultimately given rise in the bovine animal to general tuberculosis of an intense character. The disease thus set up in the bovine animal by material of human origin has been compared with that set up

in the bovine animal by material of bovine origin, and so far, both in broad, general features, and finer histological details, the two conditions have been found to be identical. The commission has, so far, failed to discover any character by which the one could be distinguished from the other, and the records contain accounts of the *post mortem* examination of bovine animals infected with tuberculous material of human origin, which might be used as typical descriptions of ordinary bovine tuberculosis.

There is no doubt that this interim report will be useful in strengthening the hands of local authorities, medical officers of health, and others, who have been struggling in difficult circumstances to obtain for the people a purer milk supply and food free from tuberculous contamination. As stated by the commissioners, the results obtained seem "to show quite clearly that it would be most unwise to frame or modify legislative measures in accordance with the view that human and bovine tubercle bacilli are specifically different from each other, and that the disease caused by the one is a wholly different thing from the disease caused by the other." G. D.

THE INTERNATIONAL ASSOCIATION OF ACADEMIES.

A COPY of the official record of the proceedings of the International Association of Academies at its plenary meeting on May 25, and of the proceedings of the section of science on the following day, has now been received from the Royal Society. The complete protocol of the meeting cannot yet be made up, because no report has yet been received of the proceedings of the section of letters; but we are informed that the proceedings on the last day of the general assembly in their plenary meeting consisted mainly of receiving the resolutions of the sections of science and of letters, and of certain complimentary resolutions with regard to the president of the meeting and to the Royal Society.

In the subjoined summary the foreign translations of the resolutions and details of the discussions have been omitted.

Wednesday, May 25.—After a few words of welcome from the president of the council (Sir M. Foster), Prof. Darboux (Secretaire perpétuel de l'Académie des Sciences) proposed Sir Michael Foster as president of the general assembly. The proposal was carried by acclamation.

The president opened the proceedings with an address, in the course of which he said:—

I accept with pleasure, though not without anxiety, the duties of the honourable though arduous post in which you have placed me, and trust that such short-comings as I may disclose may prove as little hindrance as possible to the success of our meeting. When we met in Paris our association was an infant of some fifteen months; it had just begun its dentition. It is now a lusty child of four years and more; it has cut all of its first set of teeth. I feel sure that you will join with me in the hope that its teeth will be used, never for secondary purposes, as aggressive weapons, but always for primary purposes, for carrying out the first stages of the digestion and assimilation of scientific knowledge and scientific thought into living active scientific flesh and blood. When I say "scientific" I use the word in the broad sense used by my illustrious predecessor in this chair, in his opening address at Paris, as meaning all knowledge which is exact and which can be verified. Though we call the two sections into which we divide ourselves, the one "scientific," the other "literary," we are none of us, I venture to say, satisfied with our nomenclature. We wish, all of us, that we could use names which should free us from the mere suspicion that there is even the taint of antagonism between the kinds of knowledge with which we have to deal.

The association began as a brotherhood of existing academies, but it has already advanced from brotherhood to parentage. At a meeting at Paris, the Royal Society of London excited much sympathy by its lone condition; while the delegates of most other countries represented the whole round of knowledge with which the association deals, those of England could speak of one part only. That sympathy provoked action, and led to the establishment of the British Academy for the Promotion of Historical, Philosophical and Philological Studies; and it has been one of the pleasant duties of my three years' term of office to bring about the admission of that academy into our fold.

One of the matters brought before the council of the association last year, concerning the relations of the association to proposals for international investigations requiring State aid, is placed on the agenda for the present meeting. The subject is one which demands our most anxious attention; may we be able to come to a decision which, while assuring the future usefulness of the association, may not tend to hamper scientific activity outside ourselves. On another matter, namely, the question whether the association should hold property, the council came to the conclusion that it was undesirable to attempt at present a definitive decision; and there the matter at present stands. The question does not come up for consideration at the present meeting, but it is one on which a decision must, sooner or later, be taken.

On the motion of Prof. Diels, Lord Reay was nominated vice-president.

Secretaries for the meeting were nominated as follows:—German, Dr. K. Krumbacher, Munich; French, M. A. de Lapparent, Paris; English, Dr. A. D. Waller, London.

The president proposed the following delegates as *Présidents d'honneur*:—Dr. Diels, Prof. Darboux, Count Balzani, Dr. Bakhuyzen.

Prof. Gomperz proposed that section ix. (4), (5), of the statutes be amended to read as follows:—Section ix. (4). The president (of the council) shall be appointed by the directing academy. Section ix. (5). The vice-president, who shall belong to the other section, shall be appointed in the same way. In the event, however, of the directing academy having only one section, the association shall entrust the appointment of the vice-president to another academy. The proposal was carried.

Prof. Darboux moved "That the initiation of any new international organisation, to be maintained by subventions from different States, demands careful previous examination into the value and objects of such organisation, and that it is desirable that proposals to establish such organisations should be considered by the International Association of Academies before definite action is taken." The resolution was carried.

Prof. Armstrong presented the draft report of the executive committee of the International Catalogue of Scientific Literature. Prof. Credner moved "That this meeting recognises the great value of the International Catalogue of Scientific Literature, and the importance of aiding the work by making its existence known, as well as of contributing to its efficiency and completeness by endeavouring to secure the indexing of scientific publications at the time of issue, in accordance with the plan adopted by the Royal Society." The resolution was carried unanimously.

Mr. Bryce announced that the British Academy was taking steps to publish a similar catalogue for philology, and the other branches of learning not included among the sciences of nature.

M. Boutroux gave a brief account of the work completed and contemplated in connection with the preparation of a complete edition of the works of Leibniz, and moved "That the association be requested to renew the commission to the three academies above named to prepare an edition of the works of Leibniz committed to them by the resolution of the association of April 18, 1901, and to request them to bring about, between now and the general assembly of the association in 1907, the publication of a critical catalogue, for which they have already collected the materials, of the Leibniz manuscripts." The resolution was carried.

The president proposed Vienna as the place of meeting of the next general assembly in 1907. The proposal was adopted unanimously.

Thursday, May 26.—Section of science. Secretaries were appointed as follows:—German, Dr. A. Riecke; French, M. A. de Lapparent; English, Dr. A. D. Waller.

Prof. Waldeyer presented, on behalf of the commission for investigating the anatomy of the brain, the report of the sitting of the committee of May 24.

Prof. Waldeyer moved the following resolution:—

"The several academies and societies represented in the association are recommended to bring before their respective Governments, or other appropriate authorities, in the name of the association, a proposal to establish a special institution or department of institutions for the investigation of the central nervous system, where such organisations are not already in existence, or cannot be created otherwise." The resolution was carried.

The following resolution, giving the committee power of cooption, was also carried:—

"That the Brain Commission have the power of cooption, as recommended in the report just received."

Prof. von Bezold moved "That a committee be appointed to consider the best means of bringing existing organisations into accord with the views of the International Association of Academies." This resolution was carried.

Sir A. Geikie, on behalf of the International Geological Congress, moved the following resolution:—"The International Association having received and considered a reference made to it by the International Geological Congress held at Vienna, 1903, resolves to ask the International Geodetic Association to take into consideration whether, and (or) in what way, it can undertake or promote international cooperation in the investigation of the following subjects:—

"Precise determination of levels in mountain chains subject to earthquakes, with the view of ascertaining whether such chains are stable or are undergoing movements of elevation or depression.

"Measurements of the value of gravity, with the object, so far as geological questions are concerned, of throwing light on the internal distribution of masses in the earth, and on the rigidity or isostasy of the terrestrial crust." The motion was carried unanimously.

Prof. Credner proposed that the committee on seismological investigations, appointed on the proposition of Prof. von Bezold, consist of the following members:—Prof. Schuster (chairman), Prof. Helmert, Prof. de Lapparent, Prof. Mojsisovics, Prof. Agamennone, Prof. A. P. Karpinski, Prof. W. C. Mendenhall. That the committee have power to coopt further members without votes. If a vacancy arise among the members of the committee, it shall have the power to fill up such vacancy subject to confirmation by the International Association.

Prof. Riecke moved the following resolution of the Academies of Göttingen, Leipzig, Munich, and Vienna:—

"That the International Association be requested to place the investigation of atmospheric electrical phenomena upon the list of its undertakings, and to arrange for carrying out observations upon atmospheric electricity for the period of two years at a large number of stations suitably distributed over the surface of the earth."

Prof. Schuster considered the matter to be in an experimental stage and hardly ready to be taken up by the association otherwise than as an experimental undertaking suitable for consideration by a committee, and proposed the following resolution, which was accepted by Prof. Riecke:—

"That a committee be nominated to prepare a plan for cooperation in investigations of atmospheric electricity, and to organise, if possible, such international cooperation for a period of two years."

Prof. von Bezold introduced the propositions of the Berlin Academy of Sciences relating to terrestrial magnetism, and moved "That the association nominate a special committee to consider as to the best methods of making accurate magnetic observations at sea with a view to carrying out a magnetic survey around a parallel of latitude." The motion was carried unanimously.

Sir David Gill presented the report of the Royal Society upon the undertaking for the measurement of the African arc of the 30th meridian, and moved "That the report of the Royal Society be adopted, with the following amendments, viz.:—

"That after the concluding words there be added:—

"(1) That the association notes with much satisfaction the sympathetic communication of the Imperial Academy of Sciences, St. Petersburg, on the subject of the arc of meridian, and recommends that diplomatic action be taken with a view to the extension of Struve's arc to Egypt.

"(2) The association expresses the hope that steps will be taken by the German Government under the advice of the Berlin Academy of Sciences to extend the arc along Lake Tanganyika, either by triangles extending across the lake or along its eastern coast as may be found the more desirable." The report was adopted with the additions proposed.

Prof. Fredericq presented the report of the late Prof. Marey on the work of the Institut Marey, and moved the following resolution:—

"The International Association of Academies approves the nomination of MM. Lippmann, Amagat, Charles Richet, Blix, Einthoven, Grützner, Langendorff, Schenck, Athanasiu as new members of the 'Association Internationale de l'Institut Marey.'"

"After having considered the report of the late Prof. Marey, dated May 5, 1904, on the work of the institute, the association congratulates the committee of the Marey Institute in having obtained in France recognition as being of public utility, and thus secured the permanence of this international scientific organisation. The association expresses its best wishes for the success of the scientific work undertaken at the institute." The resolution was adopted unanimously.

Other standing committees were appointed as follows:—For the investigation of terrestrial magnetism, Prof. von Bezold (chairman), Prof. Mascart, Prof. Palazzo, Sir Arthur Rücker, Lord Kelvin, Dr. Bauer, Prof. Liznar, General Rykacev, Prof. Wieckert, Dr. Paulsen.

For the investigation of atmospheric electricity, Prof. Exner (chairman), Prof. Arrhenius, Prof. Mascart, Prof. Schuster, Prof. Righi, Prof. Ebert, Prof. Riecke.

For both these committees resolutions were passed giving powers of cooption and for filling vacancies, similar to that passed in the case of the committee on seismology.

PROF. ADOLFO CANCANI.

AMONG the various sciences, the one which during the last few years has lost the greatest proportion of its workers is probably seismology. Von Rebeur-Paschwitz, M. S. di Rossi, Ehlert, Pacher, and Contarini have followed each other in quick succession, and to this death roll, with feelings of sorrow, we are called upon to add the name of the distinguished investigator Adolfo Cancani. Although connected with the University of Modena, Prof. Cancani's work was chiefly carried out while working with di Rossi at the observatory of Rocca di Papa, and later whilst engaged as an assistant at the Central Meteorological Observatory in Rome. At the former institution he introduced into seismometry the use of large and heavy horizontal pendulums the movements of which were recorded mechanically.

The first of these, which are probably the largest in the world, were 17 feet in height. The booms, made of T iron, were 10 feet in length, which at their outer ends carried in one case a block of marble and in the other a piece of pig iron. Beyond these heavy masses glass fibres recorded movements on a surface rotating at the rate of 60 cm. per hour. With this apparatus, all of which was home made, and cost but a few pounds sterling, Cancani obtained some striking seismograms.

In addition to taking this new step in seismometry, Cancani devised a photo-chronograph, various seismoscopes, and other instruments.

Although his investigations extended to several departments of earth physics, his chief works are those relating to seismology.

In July, 1903, at the Seismological Conference in

Strassburg, at which with his chief, Dr. Luigi Palazzo, he acted as a delegate for Italy, he brought forward a scale for seismic intensities which he followed by a paper on the possible relationship between small changes in latitude and the occurrence of large earthquakes. His last published paper relates to the advantages to be obtained from continuously moving high speed record receiving surfaces.

Seismologists throughout the world know Cancani's work, but those who were privileged to know him personally have stored up remembrances of an enthusiastic worker, gentle and persuasive in his speech, and with a kindliness of disposition of rare occurrence. He leaves behind a gap difficult to fill, a loss to a family, to a department, and to a new science. J. M.

NOTES.

Prof. George Darwin, F.R.S., has been elected president of the British Association for the meeting to be held in South Africa next year.

At the monthly meeting of the Royal Institution on Monday, the thanks of the members were returned to Dr. Andrew Carnegie for his donation of 1200*l.* to enable Prof. Dewar and Mr. R. A. Hadfield to prosecute their joint investigation on the physical properties of steel and other alloys at low temperatures; and to Dr. Frank McClean for his donation of 100*l.* to the research fund of the institution.

Prof. C. S. Sherrington, F.R.S., has been elected a member of the Imperial Academy of Medicine, Vienna.

It is reported that the University of Göttingen has awarded its Otto Wahlbruch prize, of the value of 600*l.*, to Prof. Wilhelm Pfeffer, professor of botany at Leipzig. The prize is awarded for the most important contribution to science during the past two years.

At the annual meeting of the Association of German Chemists, held at Mannheim on May 25, the Liebig gold medal for distinguished services in applied chemistry was presented to Dr. Rudolf Knietsch, of the Badische Anilin- und Soda-Fabrik, the discoverer of the so-called contact process of sulphuric acid manufacture.

On the recommendation of the Rumford committee, the American Academy of Arts and Sciences has awarded the Rumford medal to Prof. E. F. Nichols, of Columbia University, for his researches on radiation, particularly on the pressure due to radiation, the heat of the stars, and the infra-red spectrum.

Science announces the death of Mr. Frederick A. Walpole, botanical artist of the U.S. Department of Agriculture. He was considered the best plant artist in the United States, his drawings having been used to illustrate various reports published by the Department of Agriculture and the Smithsonian Institution, as well as the narrative of the Harriman Alaska Expedition.

A Reuter telegram from Frankfort-on-Main says that at the forty-fifth general meeting of the German Engineers' Association the Grashof medal, instituted in honour of the founder of the association, was unanimously conferred on the two pioneers of steam turbine propulsion, the Hon. C. A. Parsons, of Newcastle-on-Tyne, and M. de Laval, of Stockholm.

Through the efforts of an organisation known as the Edison Medal Association, a fund has been created to establish a medal to be known as the "Edison Medal," and the responsibility of annually awarding it has been entrusted to the American Institute of Electrical Engineers. A medal will be awarded this year by a committee soon to be selected from among the members of the institute.

Reuter's Agency learns that the expedition which left England in February under Lieut. Boyd Alexander for the forest region between the west coast and Lake Chad arrived in canoes at Ibi, 250 miles up the Binue River, in April. The explorers had already made some collections on the Binue, and intended landing at Ibi with the view of pushing north into Bauchi.

An official communication issued at Simla on May 17, and published in the *Pioneer Mail* of May 20, contains the following remarks:—"It has recently been stated in certain newspapers that the Government of India have rejected the offer made by Mr. Tata of a donation for aiding the foundation of an Institute of Science. This assertion is absolutely without foundation. So far from having rejected Mr. Tata's offer, the Government of India have promised a large subsidy to the scheme, and they have throughout the negotiations done everything within their power to facilitate its progress and aid the realisation of a project which has their fullest sympathy."

Dr. Friedrich Siemens, who died in Dresden a few days ago, was born in 1826 at Menzendorf, near Lübeck, and received his education in that town. In 1848, says the *Electrician*, he came to England to introduce his brother's, Dr. Werner Siemens, telegraphic apparatus. Afterwards he worked with his other brother, the late Sir William Siemens, and succeeded in applying the latter's regenerative principle to furnaces in combination with gaseous fuel, thereby making possible the production of open-hearth steel and the melting of glass by the continuous process in tanks. He also invented the regenerative gas burner and stove, and brought out numerous inventions connected with the glass industry.

A Reuter message from Queenstown states that Mr. Marconi is among the passengers on board the outward bound Cunard Steamer *Campania*. The daily newspaper which the Cunard Company have arranged to publish on board their four largest boats will be produced under Mr. Marconi's personal supervision. There will be a regular editor and printing staff on board each liner. The news received from shore will be supplied through Reuter's Agency. Mr. Marconi stated that he would have the *Campania* in communication with America on Monday through Cape Breton station, and would keep in communication with the Cornwall station until Wednesday night or Thursday morning.

Mr. J. Donovan, 1 Anstey Road, Denmark Hill, S.E., would be glad if psychologists or other investigators could send him information or references bearing upon the following points:—(1) A fairly representative list of animals, invertebrate and vertebrate, that make sounds in extreme pain or distress, although such sounds never serve to induce their fellows to help or relieve them, or even attempt to do so. (2) (*a*) Have any observations or experiments been made to show whether the sound or cry of pain or shock has any influence toward hindering or checking the oncoming of catalepsy or swoon in the animal producing the sound? (*b*) Are animals that do not possess means of sound production more subject to catalepsy from pain or shock than those which possess means of sound production?

Dr. Luigi Magri contributes to the *Atti dei Lincei*, xiii. (1), 9, some observations on the relation of the index of

refraction of air to the density. It appears that the index of refraction increases more rapidly under pressure than is consistent with the law $(n-1)/d=\text{constant}$, whereas the value of $(n^2-1)/(n^2+1)d$ is practically constant except at low pressures, where the observations could not be made with a great degree of accuracy.

DR. STÉPHANE LEDUC, of Nantes, has communicated to the French Physical Society a note on crystal formation, advancing the hypothesis that the phenomenon of crystallisation depends not only on the arrangement of the molecules in geometric forms, but also on the movement of these molecules through the liquid in certain regular and geometric directions. This hypothesis is based on the author's observations on crystallisation in liquids thickened by colloids.

IT is well known that two triangles in the same plane may be homologous in 1, 2, 3, 4 or 6 different ways at the same time, and that two tetrahedra may be homologous in 1, 2 or 4 different ways, it being assumed in either case that there are no common vertices. Prof. Luigi Berzolari contributes a note to the *Atti dei Lincei*, xiii. (1), 9, in which it is shown that in space of more than three dimensions two pyramidoids cannot have more than one centre of homology unless they possess common vertices or corners.

THE results of meteorological and magnetical observations made at Stonyhurst College Observatory during 1903 have been published in the usual concise form, with the exception of the valuable appendix containing the Malta meteorological returns. Father Sidgreaves states that the year will be known as the wet year, the rainfall being 11·8 inches above the annual average. Notwithstanding the unfavourable weather, the solar surface was observed on 207 days, and 141 plates have been added to the collection of stellar photographic spectra.

WE have received from the Deutsche Seewarte part xii. of *Ueberseeische meteorologische Beobachtungen*, containing carefully made observations, three times a day, at the following remote localities:—Marshall Islands (two stations), Nauru (lat. 26° S., long. 167° E.), Apia (Samoa), Tsingtau (lat. 36° N., long. 120° E.), and Rarotonga (Cook's Islands). With the exception of the latter station, all the observations were taken at the German colonies in the Pacific Ocean. It is worthy of note that the preparation of this very valuable work has been financially supported by the Colonial Department of the German Foreign Office.

CAPTAIN D. WILSON BARKER, in his presidential address to the Royal Meteorological Society, reviewed the past and present condition of ocean meteorology. The importance of this branch of science led to the international conference on meteorological observations at sea at Brussels in 1853, and to the establishment of the Meteorological Department of the Board of Trade by Mr. Cardwell in the following year, under the superintendence of Captain (afterwards Vice-Admiral) FitzRoy. He and Captain Maury in the United States (more especially the latter) are recognised as the most successful pioneers of ocean meteorology. Maury constructed wind and current charts for all oceans, copies of which were supplied gratuitously for the use of navigators in this country, and FitzRoy and his small staff at once set to work on them, and converted the pilot charts (which showed the wind directions numerically under each principal point of the compass) into graphical "wind-stars," and subsequently (about 1859) FitzRoy commenced the publication of a new series of monthly (instead of quarterly) charts, including wind-force and other data obtained from log-books collected by the Board of Trade Department. Other countries, especially France, Germany, and Holland, also pursued the subject vigorously; the Deutsche Seewarte published, among numerous other valuable works, an atlas of thirty-six charts of the Atlantic Ocean. In 1874 another international maritime conference was held in London, and was attended by representatives of all the principal nations. In this country the Meteorological Council, with the cooperation of the Hydrographic Office of the Admiralty, continues to devote untiring attention to this important subject. Captain Barker's able summary is contained in the *Quarterly Journal* of the Royal Meteorological Society for April last, and is illustrated by maps drawn on Flamsteed's projection, showing very clearly the principal meteorological elements, five or six maps being devoted to each of the great oceans.

WE have to acknowledge the receipt from the Field Columbian Museum, Chicago, of copies of three papers on mammals by Dr. D. G. Elliot, published last year.

WE regret to find that in the notice of Mr. Regan's paper on the classification of fishes in our issue of June 2 (p. 109), the Teleostei are stated to be derived from the Chondropterygii instead of from the Chondrostei.

ACCORDING to a well illustrated article in the March number of the *American Naturalist* by Prof. E. A. Andrews, the assumption that the breeding habits of the American crayfish are identical with those of its European relative proves to be incorrect, and it turns out that there are considerable differences in this respect between the two species. The second article in the same issue, by Mr. W. M. Smallwood, is devoted to the natural history of the bulla-like mollusc known as *Haminea solitaria*.

ALL recent experiments on keeping animals in menageries in the open air seem to point to the superiority over the old plan of confining them in close and narrow cages. In the report of the Zoological Society of Philadelphia for 1903, for instance, it is stated that the raccoons in the society's menagerie were recently placed in an open enclosure containing a tall tree with a cavity at the base, and a hollow log. With these natural retreats at hand, it is noteworthy that the raccoons preferred to pass their time in winter, even during most inclement weather, high up in the tree, some 40 or 50 feet above the ground. In the same report the importance of pathological investigations into the causes of death of animals dying in menageries is urged.

THE Australian Ornithologists' Union is to be congratulated on the completion of the third volume of its official organ, the *Emu*. Efforts are to be made in the immediate future to render this valuable journal more strictly scientific. The part before us contains a coloured plate of two species of honey-eater, which, although described many years ago, have never previously been figured.

ACCORDING to the report for 1903, there is a satisfactory and continuous increase in the amount of gate-money taken at the Giza Zoological Gardens, the receipts for that year being £1213 (Egyptian), against £1037 in 1902. An extremely interesting feature in the report is the notes on the habits of the numerous species of Nile fishes kept in the aquarium. From these it appears that the proboscis-fish (*Mormyrus kannume*) is chiefly nocturnal, and employs its long snout in probing about among stones for animal food.

Very remarkable is the statement that in the case of *Hydrocyon forskali* it was found advisable to keep a light burning near the tank in order to prevent the fish from injuring themselves by swimming violently against the glass walls.

An official publication issued at Colombo by the Government printer contains a summary of Prof. Herdman's report on the pearl oyster fisheries of the Gulf of Manaar, which may be considered as supplementary to the report on the same subject published by the Royal Society in November last, and already noticed in our columns. After referring to the condition and extent of the oyster-banks, the present report briefly points out the chief sources of injury to the molluscs, after which reference is made to the mode of formation of pearls, and the best methods of pearl-fishing. The report concludes with a series of recommendations, among which are comprised the substitution of dredging (in many instances) for diving, and the advisability of the appointment of a permanent naturalist.

An apparent instance of mimicry of a most remarkable type is recorded by Dr. A. Willey in *Spolia Zeylanica* for April (vol. ii., part v.). The attention of Dr. Willey had been directed by a correspondent to the striking resemblance presented by one of the Cingalese fishes commonly known as sea-bats (*Platax vespertilio*) to a decayed leaf, and soon after he had the opportunity of verifying this statement for himself. "I was walking," he writes, "along the reef in the company of a fisherman carrying a net when he espied a small fish, which he attempted to catch for me. I could not see what it was at first, but noticed that the man failed to bag it after several ineffectual attempts. The fish did not swim far away from the spot, but dodged about, baffling its pursuer. I approached and seized the net, whereupon I saw a yellow jak-leaf gently and inertly sinking to the bottom. This is no unusual sight, and I was about to turn away, when the leaf righted itself and darted off. Efforts were redoubled and the fish secured and sketched. . . . When a fish has a leaf-shaped and leaf-coloured body, and in addition the unique habit of toppling over and feigning death when pursued, it seems natural to conclude that it is a genuine example of protective resemblance."

Many of the visitors to Kew Gardens who take a special interest in the orchid houses will be interested to know that a revised edition of the "Kew Hand-list of Orchids" has been published, with the usual interleaved blank pages to facilitate the jotting down of notes. The increase in the number of genera, at any rate in the plants shown in the houses, has been very evident, and the catalogue gives a total of 220 for the collection.

The large proportion of economic questions which occupies the attention of the botanical departments in our colonies is well shown in the *Bulletins* (January, April) of the Botanical Department in Trinidad. A striking analysis of samples of sugar canes grown in Florida is quoted in an extract, in which no reducing sugar was found. The proportion of the sugars in canes is not only important from a commercial point of view, but as a purely scientific question is well worth investigating. The recommendation of carbon bisulphide as an insecticide affords evidence of the spread of scientific knowledge amongst planters. Other useful articles refer to prussic acid in cassava, rubber analyses, and treatment of "black pod" on cacao estates.

Prof. Eriksson returns to his mycoplasm theory, which asserts that rust fungi can hibernate in a protoplasmic form in the leaf-cells of the host, in a paper which appears in the *Transactions* of the Royal Swedish Academy of Sciences, vol. xxxvii., part vi., January. The investigations which were carried out by Dr. Eriksson and Dr. Tischler consisted in collecting the leaves of varieties of wheat which are liable to rust, and examining them both in late autumn and the following early summer, when no fungal mycelium could be observed, but in certain cells the authors distinguished a special dense accumulation of protoplasm, the mycoplasm. Later in July, intercellular fungal tubes were found which gradually developed into the ordinary hyphæ. The change from the mycoplasmic to the intercellular condition which is assumed still requires confirmation.

Mr. C. Fox-Strangways has prepared a second edition of his memoir on the Oolitic and Cretaceous rocks south of Scarborough (Geological Survey, price 4s. 6d.). More than twenty years have elapsed since the first edition was published, and opportunity has been taken of adding a series of pictorial views illustrating the fine cliff-sections, while the subject-matter is amplified throughout. The results of recent researches on the Speeton Clay are incorporated, and the author has dealt more fully with the interesting topics of scenery and denudation.

In an article on recent changes in the elevation of land and sea in the vicinity of New York City, and from a study of tidal observations on both sides of the Atlantic, Mr. G. W. Tuttle (*Amer. Journ. Sci.*, May) comes to the conclusion that the mean sea-level oscillates in an irregular manner, having an average period of about eight years. These oscillations appear to be largely due to changes in atmospheric pressure, and the resulting changes in wind velocities. In addition to the above movements, Mr. Tuttle finds that some ports show a more or less continuous rising of the sea relatively to the adjacent land, others a lowering of the sea-level in its relation to the land, and still others maintain a constant relation between the two. These last make it clear that, except for the periodic changes noted above, the sea does not change its level, and that the relative changes are due to land movements. Observations at New York City show that since 1875 the land has been subsiding at about 1·45 foot per century.

Messrs. Philip Harris and Co. have sent us a pamphlet giving a descriptive account of some new models and apparatus to be used in teaching the measurement of volumes, designed by Mr. S. Irwin Crookes.

Messrs. Watts and Co. have published for the Rationalist Press Association, Ltd., a pamphlet entitled "What to Read: Suggestions for the better Utilisation of Public Libraries," which contains the substance of an address delivered by Mr. John M. Robertson. Many useful hints to parents and librarians who wish to develop in children a love of reading and a regard for good books may be gathered from the address. The price of the pamphlet is fourpence.

With the growth of the Stassfurt industries and the increasing application of potassium salts in agriculture, a rapid method of estimating potassium has become a question of some importance. In the May number of the *Gazzetta*, N. Tarugi describes a volumetric method of estimating the element which depends on its precipitation in the form of the sparingly soluble persulphate. The method is accurate,

and can be carried out with great rapidity. Incidentally, the existence in aqueous solution at temperatures between 0° and 40° of four hydrates of potassium persulphate is established.

SOME experiments by Mr. K. E. Guthe, published in the April number of the *Physical Review*, show that fused steatite or soapstone can be used as a substitute for fused quartz in the production of fibres of very small elastic fatigue suitable for suspensions. The soapstone can be melted in a gas-oxygen jet, and very fine fibres are easily drawn out from the clear bead thus obtained. The elastic fatigue and tensile strength of these fused steatite fibres have approximately the same value as fused quartz fibres of the same dimensions. In the same journal Mr. J. H. Hart describes a continuous method of steam calorimetry which, with simple apparatus, gives results which compare very favourably with the best results obtained by the admittedly excellent continuous electrical method.

AN exhaustive account of investigations with the respiration calorimeter, by Messrs. Armsby and Fries, on the available energy of timothy hay has been issued as *Bulletin* No. 51 of the Bureau of Animal Industry of the U.S. Department of Agriculture. According to well known experiments of Rubner, different nutrient materials—proteids, fats, and carbohydrates—can replace each other in the animal metabolism, and "isodynamic values" can be deduced for the various nutrients. The authors question the applicability of Rubner's generalisation to herbivorous animals, and their experiments indicate that the digested matter of hay is not isodynamic with body tissue when the food supply is below the maintenance ration. It was found that only 63 per cent. of the metabolisable energy served to prevent loss of tissue, while 37 per cent. simply increased the heat production of the animal.

A VERY interesting paper dealing with the constitution of the ammonium compounds is contributed by Dr. J. C. Cain to the current volume of the *Memoirs and Proceedings* of the Manchester Literary and Philosophical Society (vol. xlviii., No. 14). To take examples, the author's suggested formulæ for ammonium chloride and ammonium hydrate are $H_3N=ClH$ and $H_3N=OH_2$, in which the chlorine and oxygen are respectively trivalent and tetravalent. The conception involved in this new formulation explains a large number of well known facts in a very satisfactory manner. It accounts for the difference between solutions of ammonia and of the alkaline hydroxides, and for the existence of isomeric quaternary ammonium salts. By means of it the formation of metal-ammonia compounds and of diazonium salts, the reduction of diazonium derivatives to hydrazine, and the process of diazotisation are all capable of simple representation.

OUR ASTRONOMICAL COLUMN.

SPECTRUM AND ORBIT OF δ ORIONIS.—Some very interesting results have been obtained by Dr. Hartmann in a research carried out at Potsdam on the spectrum and orbit of δ Orionis. The variability of the velocity in the line of sight—or, as Dr. Hartmann prefers to designate it, the "oscillation"—of this star was first discovered by Prof. Deslandres at Meudon, who determined the period as 1·92 days, and the orbit as very eccentric. Dr. Hartmann's results, however, do not confirm these conclusions, for he finds the period and the eccentricity to be

5d. 17h. 34m. 48s. ± 17s.

and 0·10334 respectively.

A striking feature on the spectrograms obtained is that the calcium line at λ 3934 ("K") is always sharp, whilst the other lines are characteristically hazy, and it *does not share in the periodic displacements of the lines caused by the orbital motion of the star.* Seeking an explanation of this anomalous behaviour, Dr. Hartmann has arrived at the conclusion that the absorption producing K does not take place in either of the components of the δ Orionis system, but in a separate "cloud" of calcium vapour situated somewhere between that system and our own. The distance of this cloud cannot be determined, but Dr. Hartmann suggests that its extent, perpendicular to the line of sight, might be approximately determined by the observation of the K line in stars situated in the same region and having "oscillations" similar to those of δ Orionis (*Astrophysical Journal*, No. 4, vol. xix.).

ANOMALOUS DISPERSION AND SOLAR PHENOMENA.—A further exposition of anomalous dispersion, and its action relative to solar phenomena, by Prof. W. H. Julius, appears in No. 10 (May 30) of the *Revue générale des Sciences.* After reviewing the current theories as to the sun's physical constitution, Prof. Julius proceeds to demonstrate that the "apparent" excessive speed of prominence variations, the abnormal solar spectrum photographed by Prof. Hale in 1894, the periodical variation of the solar radiation, the eleven-year period of solar activity, the connection between allied terrestrial and solar phenomena, and several other phenomena, may all be explained by considering the relative geometrical positions of the sun and earth, and the consequently variable distorted paths of the solar radiations. For example, he states:—"The eleven-year period may be the combined consequence of a progressive variation (not necessarily periodic) of the system of the surfaces of discontinuity and the periodic displacement of the Earth in regard to the rotating mass of the Sun."

PRIMITIVE CONDITIONS OF THE SOLAR NEBULA.—An interesting mathematical study of the conditions which probably obtained in the primitive solar nebula has been communicated to the Academy of Science of St. Louis by Mr. Francis E. Nipher, and is published in No. 4, vol. xiv., of the academy's *Transactions.* According to the equations developed by the author, it seems impossible that at the time when the planets were separating from the parent mass the nebula was wholly gaseous. The idea that the planets were formed from condensing swarms of meteorites is the only reasonable one which conforms with the numerical results obtained. It also appears that at the times when the moon separated from the earth, and Mercury from the sun, the respective parent masses must have been in the solid state, the sun having fused and become vaporised since the separation of Mercury. Further, it seems unnecessary, and even improbable, that the earth should ever have been in a state of fusion. By substituting the proper conditions in one of his general equations, Mr. Nipher finds that the isothermal 7000° C. is probably the one existing at the sun's surface at the present time.

INVARIABILITY OF SPARK AND ARC WAVE-LENGTHS.—In a paper communicated to No. 4, vol. xix., of the *Astrophysical Journal*, Messrs. Eder and Valenta describe the results they have obtained from a series of experiments performed in order to test the various theories as to the variability of wave-lengths, in arc and spark spectra, with the amount of vapour present or with the nature of the electric stimulus used.

As the result of his experiments, Prof. Haschek proposed, in a paper published in February, 1902, a system of *quantitative* analysis based on the measurement of the amount of "shift" a line experienced when varying quantities of the material under analysis were used. Taking most stringent precautions to eliminate subjective photographic effects, Messrs. Eder and Valenta have shown that these "shifts" do not really exist, and they state their conclusions in the following words:—(1) That at ordinary atmospheric pressure there exist no relative shifts between the arc and spark spectra as were said by Exner and Haschek to occur; (2) that there also exist no shifts in the spark spectrum which could be attributed to a reduced quantity of the element present in the vapour.

THE PROGRESS OF MARINE BIOLOGY.[1]

For some few years past the advances made by oceanography have been very marked, thanks to the rivalry which has grown up between different peoples. The English, the Americans, the Germans, the Belgians, the Scandinavians, and the Russians have made great efforts in this direction, while France, Italy, Austria and Portugal have not remained outside of the movement. Consequently this science in its principal features is already pretty well known.

But oceanography touches many departments of science, and amongst them marine biology is for the moment the least advanced, because it requires researches of a particularly difficult kind. It is to it that I have more particularly devoted my attention, and it is of it that I propose to speak this evening.

From the reports of many important expeditions, you are already well aware how universally distributed life is, even in the greatest depths of the sea; nevertheless, the means employed in this kind of investigation have been, as a rule, too primitive to furnish very complete results. In my own personal oceanographical work I have, for long, employed new means and methods, which attract different groups of marine animals, each according to its own characteristic instincts, and I have been able in this way to add to our knowledge of zoology.

It is not, however, enough to collect. We must also endeavour to penetrate the mystery of the laws which regulate life in the medium of the sea, so different in almost all respects from that of the air. For this the oceanographer requires the collaboration of the biologist and the physiologist.

Not unfrequently unexpected circumstances open to the observer new horizons, to be afterwards explored by science. It is thus that, finding myself among the islands of the Azores, to which my oceanographical researches have frequently conducted me, I assisted at the capture of a *cachalot*, or sperm whale, by the whalers of the country; simple peasants, who launch their well appointed whale boats the moment that the appearance of a fish is signalled by the look-out man, who is continually stationed on a little hill in their neighbourhood, and I have seen how these mammals go to the intermediate depths of the ocean in search of the great cephalopods which form their exclusive nourishment. When the *cachalot* in question came to endure the convulsions of death, its stomach rejected enormous fragments of the prey which it had captured during its last sounding.

It is in this way that I have recognised the existence of a fauna remarkable for the size and the number of its components, relegated to the large space which separates the surface from the great depths, but the organisation of which prevents its rising to the regions illuminated by the light of the sun, and probably also its descending to the bottom, when this lies beyond a certain depth.

What other groups of living animals inhabit these regions? We know nothing of them yet, but we may believe that they abound, because beings as powerful as these cephalopods require much nourishment.

So soon as I understood the importance of researches capable of throwing light on the life which exists in regions inaccessible to our ordinary means, I established on board of my ship all the equipments of a whaler, namely, three whale boats, each carrying a harpoon gun, several harpoons, a lance and a thousand metres of line, and I added to the complement of my ship an experienced Scottish whaler. The results of this organisation have left nothing to be desired. The cetaceans obtained already form an interesting collection, and their stomachs were abundantly furnished with these cephalopods.

In the Mediterranean, where previously the cetaceans had never been hunted, I have taken several individuals of the species *Grampus griseus*, *Orca gladiator*, *Globiceps melas*, and I lost a *Balenoptera musculus*. In the Atlantic Ocean I have taken several Globiceps and Grampus, as well as a very rare specimen of dolphin, *Steno rostratus*. I have also lost a cetacean of moderate size but of undetermined species.

[1] A Discourse delivered at the Royal Institution on Friday, May 27, by H.S H. Albert I., Prince of Monaco.

The attack of cetaceans, especially when they are large, causes the harpooneering novice an emotion which diminishes his *adresse*; and even for a good shot the use of the harpoon gun is very difficult when there is the least motion of the sea. A school of animals has been sighted. Their presence has been revealed by their blowing, or by the regular reappearance of their backs at a greater or less distance from the ship, which is then steered towards them. If the animals are of the species already mentioned, the movement of the propeller does not trouble them; on the contrary, they may almost always be seen to come and take up station near the stern as if retained by curiosity. But some species, and among them the *cachalot*, seem to distrust this neighbourhood, and care must be taken that they do not hear even the too marked sound of oars; indeed, in such cases it is preferable to use paddles rather than oars.

The animals have found in the depth a favourable hunting ground, and they do not leave it. They sound to this depth during a time which varies from ten to forty-five minutes, according to the species, and come to the surface again to breathe during four or five minutes. These alternations repeat themselves, sometimes for several hours consecutively, almost on the same spot, with occasional pauses, which seem to be those of repose. It is when the cetaceans appear in this way at the surface that the nearest whale-

Fig. 1.—Breaking up a Sp rm Whale.

boat should make every endeavour to come up with them before they again disappear, and so soon as one of them gives a sufficiently good presentation of the part of its body near the head, the harpooneer fires his shot. But this critical moment seldom arrives until after several hours of pursuit, even when the animals are full of confidence and allow the whalers to get well in amongst them. Most frequently, and in the most favourable circumstances, it happens that during the three or four seconds which the emergence of the animal at each of his eight or ten respirations lasts, the presentation is bad, or the movement of the sea has destroyed the aim; it is then necessary to wait until after the next sound.

If the animals sighted pursue a fixed route with any speed, it is useless to attempt the attack; it is impossible to come up with them because they are then on passage. Once I followed a large Balenoptera for six hours with my ship. He travelled about thirty miles in an absolutely straight line, which shows that the marine animals possess a sense of orientation more remarkable than that of the migratory birds, because these can always see the ground above which they travel.

At last, close to the boat, a powerful blow like a jet of

steam comes out of the water; the back of the animal emerges immediately afterwards; in the movement necessary to recover the horizontal position of its head, the dorsal fin appears and finally the lumbar region, which is much curved by the action of the tail, which determines the descent. It now proceeds for several lengths, hardly submerged, whilst the steersman, who can see the lighter-coloured portions of this immense body, and sometimes

Fig. 2.—Harpooning a Whale.

certain pools caused by the motion of the dorsal fin, steers the boat, driven by all the force of its crew, so as to cross the route of the cetacean. A fresh blow cuts the water, a black back presents itself at a distance of five or six metres, the shot is fired, and the eye can follow the harpoon with the attached line.

But at the first moment there is nothing to show that the animal has been touched. In a body of such size the arrival

Fig. 3.—Towed by a Grampus.

of sensation in the brain and the transmission of the will to the periphery require a sensible time. The success of the harpooneer is indicated by the rapid running out of the line, which very soon produces heat and a dense smoke in the bollard, round which a turn is taken in order to allow the harpooneer to regulate the run of the line according to the velocity of the cetacean and the direction which it follows. This is a very delicate moment for the safety of the whale-boat; nobody moves, and the turns of the line, carefully coiled in a receptacle, run out without a check. A second boat approaches in order to take the end of this line, when it is apparent that the thousand metres in the first boat will not be sufficient, and to add it to his own line. The running out is continued from this boat, and sometimes the three whale boats are rapidly cleared of their lines. But, with the friction which such a length of line offers, and to which the resistance of the boats towed has to be added, the cetacean reduces its speed very sensibly, so that there is no difficulty in maintaining it. Little by little the line is got back into the boats, and after various alternations the weakened animal advances more and more slowly, and close to the surface, where it is obliged to breathe more and more frequently.

Often many hours have passed before the favourable moment arrives for despatching the unfortunate victim and terminating the drama, and this is accompanied by the most serious circumstances of the whole enterprise. The exhausted animal stretches itself on the surface, almost motionless before the boat, where the harpooneer now holds a lance which has a considerable length, because it must pass through the whole thickness of the blubber and of the muscles before it reaches the vital organs. He approaches the animal by its side, so as not to be struck by the tail,

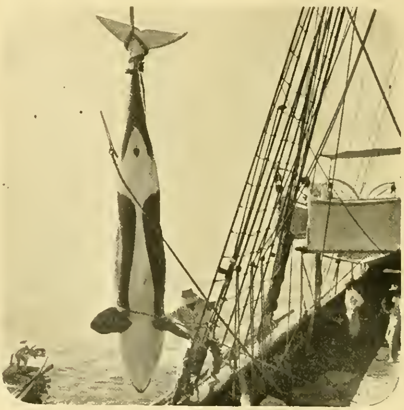


Fig. 4.—Hauling an Orca on board.

which may be thrown violently into the air so soon as the cetacean receives this new wound; but it is not always possible to avoid being struck by a fin, and especially in the case of large animals, this may wreck a boat. In spite of all the skill of the crew an accident of this kind may occur, and I could relate cases mentioned by various captains in which *cachalots*, old and solitary individuals, have seized and crushed between their jaws the boats which have attacked them. It has even been reported that two ships have been sunk by such animals in their fury, their enormous wedge-shaped head becoming in these circumstances a formidable ram.

When a cetacean of any size has been several times pierced, the red pool which spreads far over the sea gives the idea of great carnage. In fact the cetaceans contain a very large amount of blood, and before the last hour, when they lose it in torrents, they have already left behind them a red track of eight or ten miles in length over which they have towed the boats.

I have said that apart from the interest which each species of cetacean offers of itself (and it appears that some of them are hardly known at all), it is in the first place the contents of their stomachs which occupy us. The species which I have taken differ much in the nature of their prey, and their mouths are armed correspondingly. The *right whale*

is content to absorb the *plankton* composed of extremely small animals, which in some regions form a compact mass, a real cloud; and in order to keep out objects too large to pass down its very small throat, its jaws are furnished with the well known and valuable *whalebone*, which acts as a sieve.

The Grampus, the Globiceps, and the Cachalot penetrate to a depth probably much greater in search of cephalopods,

FIG. 5.—Skeleton of an Orca.

and they possess a dentition specially organised for seizing the gelatinous flesh of the cephalopods. The scars which they bear over the whole of their bodies are evidence of the energy with which their victims defend themselves with their suckers, often armed with formidable talons.

The Orca, provided with a more compact dentition, pursues the dolphins, of which it makes scarcely more than three or four mouthfuls, showing thus a remarkable power of digestion.

The dolphins themselves are more eclectic, and I have found in their stomachs several species of fish as well as cephalopods, but in both of them the characteristics special to great depths are wanting.

The principal object which I had in view in capturing the cetaceans, the knowledge of the beings living in the abysses, has been realised by the acquisition of a certain number of new and very rare cephalopods. Some of these are gigantic, and amongst them may be cited *Lepidoteuthis Grimaldii*, one of the most remarkable animals of the sea on account of its considerable size, and also because, though it is a cephalopod, it possesses scales like a fish.

The more we know of marine biology, and the more we

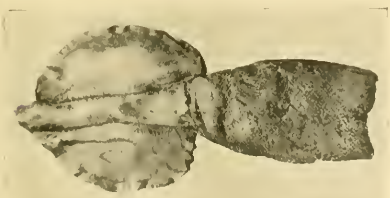


FIG. 6.—Part of the Fin of a Gigantic Cephalopod.

learn from it of the links which connect the creatures spread over our planet, of the interpenetration of types, such as that shown by Lepidoteuthis, as well as of the vital force, the great power of reproduction, the number of individuals in certain species, and the high antiquity of other forms, we seem to be justified in imagining that the sea may have been the cradle of organic life when the cooling of the atmosphere determined the precipitation of the waters.

THE ROYAL OBSERVATORY, GREENWICH.

THE report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, was read at the annual visitation of the observatory on Saturday last. Some of the results and observations described in the report are referred to in the subjoined abstract.

The progress made in the observation of the reference stars for the astrographic plates (for which more than 10,000 stars are to be observed, three times above and twice below pole) has been so satisfactory that it is expected that sufficient observations of all the stars will have been secured by the end of 1905, at which date it is proposed to terminate the observations. The catalogue of the astrographic reference stars will thus be completed in nine years, a year earlier than was originally proposed.

After consultation with Prof. Albrecht, it has been arranged to apply the correction for latitude deduced by him from the provisional discussion of the international series of observations to all observations of north polar distance year by year, commencing with 1902, Prof. Albrecht having arranged to communicate his results as soon as practicable after the end of the year. This correction has been applied to all the north polar distances for 1902 and to the planetary observations for 1903, and is now being applied in the star ledgers.

Provision having been made for the comparison between theory and the Greenwich meridian observations of the moon from 1750 to the present time, the discussion of the longitude of the moon 1750–1901, compared with revised tabular places, has been undertaken by Mr. Cowell on a plan devised by him, which enables the complex calculations to be done in a very economical manner, the lunar day being adopted as the unit of time. Mr. Cowell has published explanations of his methods of analysis of the moon's errors, together with some of the results obtained, in the *Monthly Notices* of the Royal Astronomical Society, November, 1903, to May, 1904.

The 28-inch refractor has been used throughout the year for micrometric measurements of double stars. The total number of double stars measured during the year is 512; of these, 178 have their components less than $1''.0$ apart, and 85 less than $0''.5$. The wider pairs consist of bright stars with faint companions, stars of special interest, and stars from Struve's catalogue which have not been measured within the last thirty years.

The occulting shutter has been used in the photography of Neptune and its satellite with the 26-inch refractor, and a good series of photographs has been obtained during the opposition of 1903–4. During the year the following photographs have been taken:—with the 26-inch refractor, 58 photographs of Neptune and satellite, 22 photographs of 10 double stars, 13 photographs for adjustments; with the 30-inch reflector, 117 photographs of 40 minor planets, 27 photographs on 27 nights of comet *c* 1903, 17 photographs on 12 nights of comet *a* 1904.

The photographs of comets have all been taken with short exposures, usually four on each plate, and are for the purpose of determining positions. Four exposures have also been given on each photograph of a minor planet, the object being to obtain accurate determinations of position on three or four nights for each planet during the opposition. In addition, the following photographs with long exposures have been obtained:—of comet *c* 1903, comet *a* 1904, the great nebula in Andromeda, and the Pleiades.

Considerable progress has been made with the measurement of the long series of photographs of Eros taken during the opposition of 1900–1. The measures have been made with the new micrometer described in a communication to the Royal Astronomical Society on May 13. With the magnification in use the probable error of the bisection of a perfectly defined speck is $\pm 0''.020$; the probable accidental error of a single measure of an image of Eros is found to be $\pm 0''.067$ on an astrographic plate, and $\pm 0''.040$ on a Thompson plate.

Owing to the error inherent in the star-images, the probable error of a position of Eros derived from a number of measures of four images on one plate is not nearly so small as the above measures suggest. Comparison of the positions of Eros for October 26 and 27 with the tabular places of M. Loewy's ephemeris gives a probable error of

$\pm 0''.082$ and $\pm 0''.045$ for photographs taken with the two instruments respectively. With the parallactic factor of October 26 and October 27, it results that two of the Thompson plates at the beginning of the evening compared with two at the end are sufficient to give the solar parallax with a probable accidental error of $\pm 0''.016$. We may therefore expect an adequate result for the somewhat arduous measurements and reductions involved.

No observations were made with the spectroscope during the year.

The solar activity increased considerably during the year ending May 10, the sun being free from spots on only 25 days, as against 190 in the previous year. The mean daily spotted area for 1903 is nearly six times as great as for 1902; still, as yet, the rate of increase is not so great as in the corresponding periods of the two preceding cycles. The greatest outburst of the year commenced on 1903 October 5, with the appearance at the east limb of the sun of a group of spots much larger than any seen since 1898 September. Several fine groups have appeared since.

The principal results for the magnetic elements for 1903 are as follows:—

Mean declination	16° 19'·1 West.
Mean horizontal force	4·0132 (in British units). 1·8504 (in Metric units).
Mean dip (with 3-inch needles)	67° 0' 51".

The magnetic disturbances in 1903 have shown a marked increase in number and extent. There were five days of great magnetic disturbance and seven of lesser disturbance. Traces of the photographic curves for these days will be published in the annual volume. The calculation of diurnal inequalities from five typical quiet days in each month, selected in concert with M. Moureaux and Dr. Chree, has been continued.

The mean temperature for the year 1903 was 50°·2, or 0°·7 above the average for the fifty years 1841–90. During the twelve months ending 1904 April 30, the highest temperature in the shade was 87°·5 on July 14. The highest temperature in the Stevenson screen was 84°·2, and in the observatory grounds 85°·0, on the same day. The lowest temperature of the air recorded in the year was 23°·8 on January 1. During the winter there were forty-three days on which the temperature fell below 32°·0, being thirteen days below the average number.

The mean daily horizontal movement of the air in the year ending 1904 April 30 was 300 miles, which is 18 miles below the average of the preceding thirty-six years. The greatest recorded movement was 796 miles on February 13, and the least 69 miles on January 23. The greatest recorded pressure of the wind was 36 lb. on the square foot on September 10, and the greatest hourly velocity 43 miles on September 10 and 11.

During the year 1903, Osler's anemometer showed an excess of sixteen revolutions of the vane in the positive direction N., E., S., W., N., excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded during the twelve months ending 1904 April 30, by the Campbell-Stokes instrument, was 1361 out of 4472 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0·304, constant sunshine being represented by 1.

The rainfall for the year ending 1904 April 30 was 35·42 inches, being 10·88 inches greater than the average of the fifty years 1841–90. The number of rainy days was 182. The rainfall during 1903 was 35·54 inches, the heaviest ever recorded at Greenwich during the calendar year. The summer months in particular were very wet, more than 16 inches being recorded in June, July, and August, viz. 6·07 inches registered in June, 5·27 inches in July, and 4·82 inches in August. The greatest fall registered at Greenwich in a single day for many years past, viz. 2·46 inches, occurred on July 23. In 1904, January and February were wet months, so that the total fall from 1903 March 1 to 1904 February 29 was more than 37 inches.

The determination of the longitude of Potsdam by Prof. Albrecht and Dr. Wanach was completed in July. The result, which has been recently published by Prof. Albrecht, leads to an indirect determination of the longitude of Paris which is in close accordance with the results obtained by the Greenwich observers in 1902.

The revision of Groombridge's Catalogue for 1810, in connection with the Greenwich Second Ten Year Catalogue (1890), and the determination of the proper motions of about 4000 stars from Groombridge's observations, compared with recent Greenwich observations at an interval of about eighty years, have now been completed under Mr. Thackeray's supervision, and the results will be published without delay.

HIGHER SCIENTIFIC EDUCATION IN FRANCE.

At one of a series of education conferences held recently at the École des Hautes Études Sociales in Paris, Prof. Appell, of the University of Paris, delivered an important address on the present facilities provided in France for higher instruction in the various branches of science, paying special attention to institutions established for this purpose in Paris. The address is published in the *Revue générale des Sciences* for March 30 last.

The address opened with a general historical account of the evolution of current estimates of the importance of scientific education of university standing and of the stages in the growth of French institutions in which such higher instruction is now given. Prof. Appell then recapitulated concisely the actual organisation of higher scientific teaching in existing schools and colleges in France, and supplemented his survey by indicating various improvements he considered desirable. Agreeing with British men of science, he urged that students must from the beginning of their work be led to avoid "une tendance fâcheuse à se contenter d'apprendre et de répéter la parole du maître," and that the object of all teaching should be to develop the scientific spirit and to encourage in the students a desire to apply to everything the methods of research.

The succeeding section of the discourse was concerned with scientific education in its relations to the practical applications of science to the needs of industry. A very liberal interpretation was given to the expression "technical" school, and the term was used to include such institutions as the schools of pharmacy, schools of mines, and agricultural colleges. Prof. Appell pleaded for a differentiation of the functions of the numerous establishments in which higher scientific education is being given, and in speaking of the work of all these technical schools, emphasised the great importance of insisting upon a good basis of general scientific knowledge on which to rest all instruction in technology. The absence of a due co-ordination of the work of existing scientific institutions in Paris was then pointed out, and a scheme outlined indicating the changes and developments desirable in order to realise "une union féconde entre la science et les applications."

The concluding subject of the address appeals in an especial manner to readers of NATURE. In it Prof. Appell indicated the increasing need in modern times for every great nation to encourage scientific research liberally. He condemned the danger most likely to exist in a democracy of judging the importance of a chair or lectureship at a university by the number of students it attracts; the test ought rather to be, it was pointed out, the number of discoveries which can be associated with a given laboratory or the amount of research work done in connection with it. The fallacy of disparaging new results in science because at the time they appear only of theoretical interest was demonstrated by reference to the researches of Newton and Pasteur. Suggestions were then made as to how to encourage the best students of science to devote a number of years to research work, and also in the direction of ensuring the most scientific and economical arrangement of buildings intended for research work in science. As an example, Prof. Appell referred to one of the needs of the University of Paris. This want was described as the creation on a large site, distinct from the Sorbonne, of an institute of chemistry, where laboratories for, and advanced instruction in, inorganic, organic, biological, and technical chemistry could all be found under the same roof, instead of being situated, as they actually are, in three distinct parts of Paris.

The concluding portion of the address is a powerful plea for the adequate endowment of research of all kinds. As Prof. Appell showed, it is in research laboratories that advances in industrial processes are really made, and it is a wise economy to encourage the foundation of such institutions. The discourse should have an immediate beneficial effect on the further supply of higher scientific education in France, and it is probable that the lessons drawn by Prof. Appell from Charlottenburg and from similar American technical institutes will serve to demonstrate to French statesmen the importance of the subject with which the address deals with such ability.

SOFT CHEESE-MAKING IN THE HOME COUNTIES.

IN the rapid increase of grass land during the last thirty years, farming in the Home Counties has seen a remarkable change. The exhaustion of land by the too frequent growth of cereals during the period of high prices, and the fall in the price of corn since, made corn, as the main product of farming, unprofitable to cultivate in part of this district. The land has been laid, or in too many cases has been allowed to lay itself, down to grass, and, instead of corn, milk has now become the principal agricultural product. This change is most noticeable within a circle having London for its centre and a radius of thirty or forty miles, for milk is both bulky and perishable, and railway charges and time in transit both desiderate its production near the great centre of consumption.

It must not be supposed that the greater part of this area is particularly well suited for grazing purposes. On the contrary, unlike the west country, or the polders of Holland, where second year's grass has all the appearance of an old pasture, it takes twenty years to produce a good pasture on the London-clay or Boulder-clay soils. It was one of the most mischievous effects of the high price of corn in the middle of the last century that the good old pastures, which formed perhaps one-third of most of the farms, were broken up. Besides, even when a good pasture has been produced, the climate is not humid enough in summer to produce an abundant growth; it is rare to get more than one cut of meadow-hay in a season, and the aftermath generally provides indifferent grazing. Per acre, the returns in milk are therefore not great. No doubt the output might be greatly increased by introducing the Danish system of dairy-farming, *i.e.* growing a succession of green tillage crops for feeding the cows instead of pasturing them, but the scarcity of cheap labour, which is the most serious drawback to intensive farming in the neighbourhood of London, prohibits the practice of this system.

The time of year when the milk production is greatest is the month of May. From observations made in Essex last year it was found that the yield of milk in May was about 20 per cent. greater than in the winter, while during the summer it fell off to an equal extent as the quality of the grazing deteriorated. The consumption of milk in London, on the other hand, fluctuates but little, and farmers must therefore limit their sale to their minimum output, and are unable to take advantage of the flush of milk in the spring to increase their returns.

It is clear that dairy-farmers require some outlet for this surplus milk. To give it to the calves and pigs is to utilise it for a purpose for which foods purchased at half the price per food unit would serve equally well. Taking everything into consideration, the use to which it could most profitably be put is in the making of soft cheese, for which there is a ready demand whenever placed on the London market. Soft cheese-making requires none of the expensive appliances and little of the storage that are necessary for hard cheese-making, and there is nothing to hinder its being carried out on any farm. But it needs knowledge and skill, and this is a subject of agricultural instruction, therefore, which the education committees in the Home Counties could most usefully provide.

Very opportunely, a little handbook on soft cheese-making has recently appeared,[1] for the preparation of which the authors, in virtue of their experience at Reading and Wye, are particularly qualified. First and foremost they lay stress on the need for cleanliness in the handling of milk, for, as they point out, taints are far more noticeable, because further developed, in soft cheese than in the milk from which it is made. But even in the production of milk for sale, reform in the matter of cleanliness is badly needed. Nowhere probably in the whole of Europe are cows kept in a filthier condition than in parts of England and Wales, and it is not unknown to find in milk a sediment of hair, dust and dung, which points to dirty cattle. In Holland and Hungary the cows are regularly groomed, and this is not only done to prevent contamination of the milk, but also because the cows, being made more comfortable, do better and give more milk. Besides dirtiness of the cows, contamination of milk is due to a variety of causes—dust blowing in an ill-kept, windy byre, neglect of the milkers to wash their hands before milking or to put on a clean over-jacket, the use of impure water for washing pails and churns, &c., and it must be remembered that not only is such contamination an injury to the public, but it is sometimes the cause of loss to the farmers themselves when milk is returned to them as unsaleable. Short courses of instruction in the handling of milk for farmers and farm hands are badly needed. It may be doubted whether, without systematic science training, all the sources of bacterial contamination of milk can ever be guarded against, and it is to be urged that the county education committees should also provide for instruction in dairy bacteriology for those who, though a limited few, will, when distributed through the farming community, gradually spread the knowledge of the possible sources of bacterial contamination.

Once the principles of cleanliness have been mastered, the making of soft cheese is merely a matter of practice and attention to the details which are admirably set out in this little handbook. Of the sorts of cheese for making which directions are given, Bondon, Coulommier and Cambridge may be specially recommended, because they are milk cheeses and will consume the whole of the surplus milk on a farm, and because they need no ripening, and therefore require no storage accommodation. For the first-named especially there is known to be a good demand in London. They can all be made at any farm where a room capable of being kept at a uniform temperature is available, by the purchase of 5*l.* worth of appliances.

This is only one of the directions in which education committees in the Home Counties can directly aid the new style of farming, and in the neglect of which they will lose a splendid opportunity for usefulness. Greater productiveness of the land by more rational manuring, more economical feeding of dairy cattle, and improvement in the milk-producing qualities of dairy herds, are also needed to make the industry fairly profitable. In the writer's experience the majority of farmers feel their difficulties far too acutely to reject any means of improvement which are provided in a form of which they can make practical use.

T. S. D.

[1] "The Practice of Soft Cheese-making." By C. W. Walker-Tisdale, F.I.C., and T. R. Robinson, F.S.I. Pp. 51. (London: Office of the *Dairy World* and *British Dairy Farmer*, 1903.) Price 1*s.*

INHERITANCE OF PSYCHICAL AND PHYSICAL CHARACTERS IN MAN.[1]

IN his Huxley lecture, Prof. Karl Pearson gives the result of a prolonged investigation into the inheritance of the mental and moral characters in man (see NATURE, vol. lxviii. p. 607, October 22, 1903). His main conclusion is a remarkable one; it is that "the physical and psychical characters in man are inherited within broad lines in the same manner, and with the same intensity. . . . We inherit our parents' tempers, our parents' conscientiousness, shyness and ability, even as we inherit their stature, fore-arm and span."

Great as are the obstacles in the way of a precise determination of the power of heredity in the physical sphere, those in the psychical are far greater. This arises partly from the difficulty of obtaining trustworthy evidence in the

[1] "On the Inheritance of the Mental and Moral Characters in Man, and its Comparison with the Inheritance of the Physical Characters." The Huxley Lecture for 1903. By Prof. Karl Pearson, F.R.S. Pp. 179–237. (Published by the Anthropological Institute of Great Britain and Ireland, 3 Hanover Square, London, W.)

latter case, partly from the absence of any definite standard of measurement. Prof. Pearson, with characteristic ingenuity, has found means of overcoming both kinds of difficulty, and has succeeded in showing that for the inheritance of all observed traits, whether belonging to the "mental" or "bodily" category, the slope of the "regression" line closely approximates to the same value, viz. 0·5. Considering the extent to which the personal element must needs enter into any estimate, however careful, of comparative ability or character, the uniformity shown by the author's tables is far greater than might have been expected. Some, indeed, may incline to the opinion that he proves too much, for if the influence of heredity is supreme alike in the mental and moral, and in the physical domain, what room is left for the action of teaching, training, discipline, and the environment generally, influences which the common experience of mankind has held to be of importance? Prof. Pearson partly meets the difficulty by reminding us that "the average home environment, the average parental influence is in itself part of the heritage of the stock." This is true enough, but scarcely covers the whole ground, because a great deal of the average environment is not parental.

Still, however firmly we may be convinced of the power of education to foster desirable qualities of whatever kind, there can be little doubt of the significance of the author's figures with regard to the material on which education and experience have to work. From these considerations there emerges a practical conclusion of the highest importance. "Intelligence," says Prof. Pearson, "can be aided and be trained, but no training or education can *create* it." "The mentally better stock in the nation is not reproducing itself at the same rate as it did of old; the less able, and the less energetic, are more fertile than the better stocks. No scheme of wider or more thorough education will bring up in the scale of intelligence hereditary weakness to the level of hereditary strength. The only remedy, if one be possible at all, is to alter the relative fertility of the good and the bad stocks in the community."

F. A. D.

ANTHROPOLOGICAL NOTES.

WE have frequently directed attention to the splendid work done by Mr. Clarence B. Moore in his archæological investigations in Florida. In the second series of the *Journal* of the Academy of Natural Sciences of Philadelphia, part iii. of vol. xii. is devoted to a memoir on certain aboriginal mounds of the Florida central west coast, and, like Mr. Moore's previous publications, it is sumptuously illustrated. Perhaps the most interesting find is a fish-spear of native copper; this is a unique record for Florida. There is little doubt that the ancient coppersmith had arrived at the knowledge that hammering the metal gave it stiffness. Numerous copper ornaments were found, such as pendants and ear-plugs, some of the latter being decorated with symbolic designs. None of the skulls from this district exhibited cranial flattening, though it was extensively practised on the north-west coast of Florida. In the latter district were found ceremonial vessels in which large holes had been made before the firing of the clay, but they do not occur along the central west coast. The mounds on the Apalachicola River yield forms of burial similar to those prevailing along the north-west coast of Florida. Ceremonial vessels, "killed" by a basal perforation and by holes throughout the body, made before the firing of the clay, were found in considerable numbers; the ware is most inferior in quality, as might be expected of vessels purposely made for interment with the dead.

There was a spirited discussion in the *American Anthropologist* during 1903 concerning the origin of the sheet copper found in the Florida mounds. Mr. J. D. McGuire contended that it owed its origin to European influences, but the whole weight of evidence and experience was against him.

There is immense variety in the basketry of the native tribes of America as regards form, technique, decoration and the materials employed, and our colleagues of the United States fully realise the importance of studying the designs with which so many baskets are ornamented while there is yet an opportunity of discovering their significance. We have several times referred to this subject; the latest publication of this kind is an admirably and copiously illustrated memoir, by G. T. Emmons, on the basketry of the Tlinget, in the *Memoirs* of the American Museum of Natural History (vol. iii. part ii.). The accuracy with which designs have been preserved and transmitted through so many generations is evidence of the conservatism of primitive peoples; most of the patterns of the past may be seen in the work of to-day, but the modern tendency to produce new figures is born of the rivalry in trade. The old characters are being combined to form attractive though meaningless figures, and so symbolism in design will gradually be lost. In existing circumstances the future of basketry is not difficult to foresee; the younger generation learns to read and write, but seldom learns to weave, and so the time is not far distant when Alaska must follow in the footsteps of all the basket producing countries. It is fortunate that, in the meantime, we have such an admirable piece of work as Mr. Emmons has produced, as he has saved from oblivion the meaning of many patterns and designs.

The following ingenious method of ethnological investigation adopted by Mr. E. Thurston, superintendent of the Government Museum, Madras, is worth rescuing from the oblivion of the report for the year 1902–1903. "In the inquiries concerning manners and customs, a novel and eminently effective method of arriving at the truth concerning tribal ceremonials was resorted to, marriage and death ceremonies being acted in the form of theatricals in which each performer at the real ceremony was represented by a member of the class concerned. In this way the interest was thoroughly sustained, and the fatigue, which soon supervenes among illiterate people when they are interviewed, was avoided. Moreover, apparently trivial but really important points of detail were clearly brought out in a manner which is impossible by mere oral examination. I have myself had to play the part of maternal uncle, and, as representing the *swami*, to receive the obeisance of the mock bride. The leading *rôle* of corpse at a funeral was played either by an elderly man or by a clay votive figure purchased from a local potter. The pupils of the eyes of these figures are not painted in till they are taken to the temple, where *puja* is done to them, as it is the painting of the eyes which endows them with life."

In the report on the administration of the Government Museum of Madras for the year 1902–1903, Mr. E. Thurston writes:—"Two tours were made in the course of the year. During the first of these the physical measurements of the jungle Uralis and Sholagas of the Coimbatore district were examined by myself, and their visual acuity, colour vision, &c., by Dr. W. H. R. Rivers, of Cambridge. It took many months before confidence was restored among these primitive folk, who, as a report records, 'could not understand why the measurements of the different organs of their bodies were taken; perhaps to reduce or increase the size of their bodies, to suit the different works which they were expected to do near London.' They believed, too, that the variously coloured wools, given to them for selection, were for tying them captive with. . . . A prolonged halt was subsequently made at Coimbatore, where the Kaikolans, Oddes, Okkiliyans, &c., were investigated. The Oddes, unfortunately, all have the title Boyan added to their names, and a fatal rumour was spread among them that the object of my visit was to transport the strongest among them to South Africa, to replace the Boers who had been killed in the war. My evil eye was cast on them, and they refused to fire a new kiln of bricks for house construction till my departure from their midst."

In appropriate yellow guise is published a new illustrated quarterly review called *Buddhism*, by the International Buddhist Society, at the Hanthawaddy Printing Works, Rangoon. The first article of the second number gives an account of the election and installation of the Taunggwin Sayadaw as Thathanabaing of Upper Burma. This functionary is the patriarch or ecclesiastic head, who is supreme in all matters connected with religion, and next to the king is the person most held in esteem. It is eight years since the last Thathanabaing died, and the people were as sheep without a shepherd, and feared that the Government would never exert its royal prerogative and elect a successor; but to their intense relief and satisfaction this was done in November, 1903. The review contains an

interesting paper on the Pali and Sanskrit texts by Prof. T. W. Rhys Davids. Judging from the other articles, this new journal should perform a useful service in clearly pointing out the true nature of Buddhism. In common with other religions, Buddhism has many extraneous local beliefs and practises grafted upon it from which it requires to be pruned. The foreigner too often does not distinguish between these two elements, and from this point of view alone the review will perform a useful task.

The brilliant work done by Prof. G. Elliot Smith on the mammalian brain is acknowledged by all anatomists, and they will eagerly look forward to the memoir (which is based on the examination of more than 400 human brains, and of an almost equally large series of simian cerebral hemispheres) that is shortly to be published as vol. ii. of the "Records of the Egyptian Government School of Medicine." A summary of the main conclusions is published in the *Anatomischen Anzeiger,* Band xxiv. p. 436. The most striking result of this investigation is the demonstration of the fact that the sulci called "calcarine" in most human and all simian brains respectively are not strictly homologous. The so-called "calcarine fissure" of the apes is a complete involution of the whole mesial part of the area striata, fossa striata occipitalis, whereas the similarly named furrow in the human brain consists in most cases of anterior and posterior parts which are genetically distinct, the anterior part being the anterior limiting sulcus of the mesial area striata, sulcus præstriatus, and the posterior part a mere depression in (not a complete infolding of) the mesial area striata, sulcus intrastriatus.

Those interested in human craniology are aware that Prof. Sergi, of Rome, has inveighed against the cephalic index, and has introduced a new nomenclature for describing skulls by inspection. Several English anthropologists recognise that the cephalic index has its uses and abuses, but there is an indefiniteness about Prof. Sergi's nomenclature, which besides is somewhat complicated, that prevents them from adopting the latter to the exclusion of the former method. As a matter of fact, they employ both systems, but only make use of the simpler terms introduced by the Italian anatomist. Dr. F. Frassetto has now applied Prof. Sergi's method to the anthropoid apes, and the following are his main conclusions. The skull of the adult chimpanzee is byrsoides rotundus, the less fully grown skull is byrsoides cuneatus; there is progressive reduction in the cephalic index, 88 to 70. The skull of the adult gorilla is byrsoides asciformis, while that of the young is ellipsoides cuneatus; there is a similar reduction in the cephalic index during growth, and the average breadth is less. On the whole the skull of the orang-utan is sphæroides and platycephalus; the cephalic index varies from 91 to 75. Thus the Asiatic anthropoid tends to preserve the primitive brachycephaly, while the African forms, especially the gorilla, become dolichocephalic. The author directs attention to the essential brachycephaly of Asiatic man and the dolichocephaly of African man. Pithecanthropus, however, which he describes as byrsoides asciformis, "is a fossil form of African anthropoid found in Asia." This short but suggestive paper will be found in the tenth anniversary volume of the *Atti della Società Romana di Anthropologia* (Rome, 1904.) A. C. H.

INTERNATIONAL OCEANOGRAPHY.[1]

THIS first instalment of the observations of the international scheme of deep-sea investigation proves conclusively the unique value of the undertaking, launched amid many difficulties, both for the advancement of the purely scientific interests of marine zoology and meteorology, and for their practical applications to matters of fisheries and weather forecasting. It contains the numerical results of the observations made during August, 1903, by ships sent out specially by no less than ten countries—Belgium, Germany, Denmark, England, Finland, Holland, Norway, Russia, Sweden, and Scotland. The classification is that of the council, and we may ignore any question as to the international relations of Sweden and Norway, Finland and Russia, or England and Scotland, and congratulate ourselves on the fact that so many nationalities have been found to agree to meet on neutral territory and to engage in a uniform scheme of scientific research, as of happy omen.

The *Bulletin* is divided into four sections, A, B, C and D. Section A consists of a table of observations of the condition of the atmosphere as to its temperature and movement, and of the condition of the surface water as to its temperature and salinity. The distributions disclosed by the data are shown graphically on two maps, one on a scale of 1 : 18,000,000, which includes the whole area, the Baltic, the North Sea, the North Atlantic and the Arctic, and another, on a scale of 1 : 6,000,000, giving the North Sea, the English Channel, and the Baltic entrance, in more detail. The maps contain much that is of supreme interest, but it is greatly to be regretted that advantage has not been taken of the skill and enthusiasm of the commanders and officers of ships crossing the Atlantic in lower latitudes to extend the maps into the region in which the explanation of facts they show is to be looked for.

In Section B we find the observations of temperature and salinity at various depths. The salinities are determined by chlorine titration of water samples collected, and from these and the observed temperatures the specific gravities *in situ* have been computed. These tables profess a high degree of accuracy—temperatures to hundredths of a degree, salinities to two places of decimals, and specific gravities, in some cases, to six places—but it seems hardly necessary to inquire whether all the figures given are significant or not, or, if they are, whether it is worth while to trouble about the necessary refinements when observations taken from ships, the positions of which are scarcely known to within a mile or two, on any day during a month, are lumped together as if they were absolutely simultaneous. For in the end we obtain a series of sections which is absolutely invaluable. Discussion of these sections is impossible in the space available here, and in any case it will be better delayed until further bulletins provide material for comparison. We may, however, instance as of special interest the sections across the Færöe-Shetland Channel furnished by the Scottish Fishery Board, and the parallel section from Bergen to Iceland of the Danish and Norwegian observations. We are now in possession of a number of sections in this region for different years, and the constant change in the relation of the northward and southward moving streams is a phenomenon of ever-increasing interest.

Section C contains the results of gas analyses of a number of the samples collected by the German, Dutch, and Danish vessels. It is to be hoped that the other nationalities will join in this very important part of the work. The last section is devoted to tables showing the distribution of plankton.

It is worth noting that four of these bulletins will constitute one volume, for which the subscription is one pound.

H. N. D.

[1] "Conseil permanent international pour l'Exploration de la Mer." *Bulletin* des Résultats acquis pendant les Courses périodiques, No. 1, Août, 1903.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Beck, master of Trinity Hall, has been elected Vice-Chancellor for the ensuing academical year.

Prof. Howard Marsh has been approved for the degree of Master of Surgery.

The Vice-Chancellor has published to the Senate a resolution unanimously passed by the Association of Chambers of Commerce of the United Kingdom supporting the recent communication from the council of the Royal Society, and urging that steps be taken to "ensure that a knowledge of science is recognised in schools and elsewhere as an essential part of general education."

The special syndicate appointed for the purpose report in favour of the university granting a diploma in mining engineering to members of the university who have completed six terms' residence, and have pursued an approved course of theoretical and practical study in the subject.

Prof. Ewing's Rede lecture, on the structure of metals, will be delivered in the anatomy and physiology lecture room on June 11 at 11.30 a.m.

Prof. W. H. Perkin, F.R.S., of Manchester, has been appointed an elector to the chair of chemistry and to the Jacksonian professorship.

Dr. L. Humphry, Dr. S. West, Dr. W. Hale White, and Dr. J. Rose Bradford, F.R.S., have been appointed examiners in medicine; Dr. Handfield-Jones and Dr. Herman, examiners in midwifery; Mr. Clinton Dent, Mr. Edmund Owen, Mr. Mansell Moullin, and Sir Hector Cameron, examiners in surgery for medical degrees.

Two portfolios of valuable drawings, illustrating ophthalmology and otology, have been presented to the university by Dr. Ole Bull, of Christiania. They will be exhibited at Oxford next month by Prof. Clifford Allbutt.

Sir William H. White, K.C.B., F.R.S., will open the new workshops, laboratories, &c., at the Merchant Venturers' Technical College, Bristol, on Wednesday, June 29.

At a meeting of the council of University College, London, on Monday, June 6, Dr. Gregory Foster was appointed principal of the college as from September 1 next, in succession to Dr. Carey Foster, who had intimated his intention not to seek re-election on the expiration of his office at the end of August. Mr. Tansley was appointed lecturer in plant anatomy for a term of three years. Mr. E. C. C. Baly was re-appointed lecturer in spectroscopy for a term of three years.

It is announced in *Science* that the Bill appropriating 50,000*l*. for the erection of a building for the College of Agriculture at Cornell University has been signed. From the same source we learn that Mr. Eugene N. Foss has given 10,000*l*. to the University of Vermont for the million dollar fund which the graduates of that college are trying to raise to mark the centenary of the institution; and that the will of the late Mr. Solomon Loeb, of New York City, has given 2000*l*. for the Chemical Laboratory of the New York University, 2000*l*. for the Hebrew Technical Institute, and 1000*l*. to the American Museum of Natural History.

In a copy just received of the Johns Hopkins University *Circular*, we notice a feature that might well be copied by other institutions of a similar kind, viz. the publication of "Notes in Biology," edited by Prof. Brookes, and "Notes in Mathematics," edited by Prof. F. Morley. A very useful purpose is served by the publication of such "notes" in a university journal, which would hardly be a suitable medium for the detailed exposition of the results of lengthy researches. In the biology notes the body cavities and nephridia of the Actinotrocha are discussed by Dr. R. P. Cowles, while the mathematical notes deal with linear correspondences, the orthic cubic curve, and the construction of quadric polarity in space.

The North of England Education Conference, which met for the first time in Manchester in January, 1903, and held its second meeting in Leeds in the early part of the present year, is to meet on the next occasion in Liverpool. The first meeting of the executive committee appointed to make arrangements for the next meeting of the conference was held at Liverpool on Friday, June 3, when Alderman W. Oulton, chairman of the Liverpool Education Committee, was appointed chairman of the executive committee, and Mr. E. M. Hance and Mr. W. Hewitt were appointed joint secretaries. It was decided that the conference should be held on Friday, January 6, and Saturday, January 7, of next year, and a general purposes subcommittee was appointed to make arrangements as to the subjects for papers and discussion.

A public meeting of residents of the central part of Calcutta was held on May 4, the *Pioneer Mail* states, with the object of promoting the advancement of scientific and industrial education among Indians. In opening the meeting, Mr. Norendro Nath Sen remarked that a lakh of rupees was required annually, to be devoted to scholarships for deserving students to enable them to proceed to England, America and Japan for the study of the industries and arts of those countries. The marvellous progress of Japan, the speaker continued, is due entirely to education in this direction. The people of India cannot be too grateful to the Government of India for providing scholarships, but the Government should not be allowed to carry the burden alone. It is left to the residents to develop and complete the work begun by the Government, and it is for this purpose that the movement has been started. The formation of local associations such as this one in Calcutta should have an excellent effect on scientific and technical education in India.

It has for some time past been a matter of comment that while American universities, and in several cases foreign ones—such as the University of Leyden—have frequently devoted considerable sums of money to the endowment, and in some instances to the separate publication, of scientific transactions, our English universities have not only been unable to subsidise the publication of researches, but have in most cases even failed to give their staffs sufficient leisure for the efficient prosecution of original work. The appearance of a paper by Prof. Karl Pearson on mathematical contributions to the theory of evolution, bearing on the title-page "Department of Applied Mathematics, University College, University of London—Drapers' Company Research Memoirs," is significant in more ways than one. It represents the fact that, probably for the first time, a City company has given an endowment of 1000*l*. to a university for the furtherance of research pure and simple, and further it indicates that mathematical research is at last beginning to receive public recognition. The present paper deals with the theory of contingency and its relation to association and normal correlation.

The attention of the reader who is interested in the teaching and development of mechanics and mathematics is directed to an important address by Prof. A. Sommerfeld, of Aachen, on "The Scientific Results and Aims of Modern Applied Mechanics," of which an abridged translation, by Mr. R. M. Milne, has appeared in the *Mathematical Gazette*. The address is a powerful statement of the now prevalent view that in teaching mechanics the foundations must be securely laid by systematic experimental work on the part of the students themselves, for whom suitable facilities must be generously provided; it is also a plea for a closer attention on the part of mathematicians to the problems of practical mechanics. In this country these doctrines have long been associated with the name of Prof. Perry, F.R.S., and one of the latest phases in the movement is the reform of the teaching of elementary mathematics. Prof. Sommerfeld states that most of the German high schools now possess richly equipped laboratories for research and instruction in mechanics, and that the value of such work is generally recognised and greatly appreciated. He also describes the nature of some of the experiments and investigations that are carried out in these laboratories.

It is satisfactory that there seems to have been a general agreement among the speakers at a recent meeting of the National Association of Manual Training Teachers—held to discuss the references to manual training in schools in the reports of the Mosely Educational Commission—as to the need in all schools for practical work conducted on scientific lines. Mr. Mosely said that the broad-minded way in which American engineers tackled the problems brought before them was what first excited his interest in the system of education in the United States. Mr. Mosely agrees with Prof. Armstrong that it is the fourth "R" which makes all the difference between the educational results in the United States and in this country. American teachers are right in giving more attention to the teaching of how to reason in a scientific manner than is common in English schools. Prof. Armstrong, who also spoke at the meeting, deprecated the erection of what he called "a magnificent metal workshop here and a magnificent wood workshop there," and said a large supply of costly machinery of one kind is unnecessary. A variety of occupations rendered possible to the boys is what is wanted, and the manual training thus provided should be related to local requirements.

SOCIETIES AND ACADEMIES.

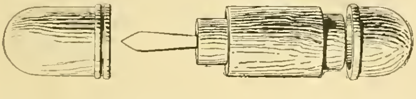
LONDON.

Royal Society, March 17.—"On the Effect of a Magnetic Field on the Rate of Subsidence of Torsional Oscillations in Wires of Nickel and Iron, and the Changes Produced by Drawing and Annealing." By Prof. Andrew **Gray,** F.R.S., and Alexander **Wood,** B.Sc.

May 5.—"Experiments on a Method of Preventing Death from Snake Bite, capable of Common and Easy Practical Application." By Sir Lauder **Brunton,** F.R.S., Sir Joseph **Fayrer,** Bart., F.R.S., and Dr. L. **Rogers.**

Although this paper is a joint one, the authors mention that each had a different share in its production. The whole research may be regarded as the natural outcome of the work begun in India nearly forty years ago by Fayrer; the instrument employed was designed by Brunton and the experimental work was carried out by Rogers.

Of late years a great deal of important and instructive work has been done by Fraser, Calmette and others in regard to the preparation of antivenins, the injection of which will preserve life in animals poisoned by snake venom. This method of treatment, however successful it may be, is open to the objection that its application is very limited, as it can only be employed in places where the antivenins can be stored ready for use. In order that any method of preventing death from the bites of snake poison should be of much practical utility, it must be one which can be constantly at hand when wanted and easy of application by unskilled persons, and as it is especially needed by very poor people, such as the natives of India, it must also be very cheap. In connection with this paper, an instrument which seems to promise good results was shown at the Royal Society. It consists simply of a small lancet about



half an inch long with a hollow wooden handle, in which crystals of permanganate of potash are contained. The way in which it is proposed to apply the permanganate is, that anyone bitten by a snake should at once tear a strip from a turban, shirt or any other article of clothing, and tie it as quickly as possible above the bite. A cut should then be made with the lancet over the site of the bite so as to convert the puncture made by the snake's tooth into a small wound. Into this the crystals of permanganate of potash, moistened with saliva if necessary, are to be rubbed. Permanganate of potash as an antidote to snake poison was first used by Fayrer in 1869; it was shown by Wynter Blyth in 1877 to be a complete chemical antidote to cobra venom, when mixed *in vitro*, and his results were confirmed by Brunton and Fayrer in 1878. The anti-vivisection law prevented them from carrying these experiments further at the time, but their continuance in this country has now been rendered possible by Dr. Waller's invention of a method of giving chloroform continuously for forty-eight hours or more. By means of this instrument Captain Rogers has been able to test the effect of permanganate of potash applied in the manner already described on rabbits and cats. Five out of six animals experimented upon survived after the injection of cobra poison, and a similar number survived after the use of Daboia poison. These experiments, which were entirely carried out by Captain Rogers, are very satisfactory, inasmuch as they show that the utility of permanganate of potash is not confined to one class of venom, but that it acts equally well with the venom of all kinds of snakes. The results obtained five minutes after the injection of the poison were as good as half a minute after injection, so that although very rapid absorption occurs during the first few seconds, it seems probable that absorption soon becomes slow from local effusion, and that sufficient time would thus be afforded for the application of the proposed antidote. Further experiments will be carried on by Captain Rogers in India, and if they prove as successful as those which he made in this country, it is proposed that lancets,[1] with full directions for use, should be sold at a very cheap rate at all the post offices in India, in the same way as packets of quinine are sold at present. If the plan of treatment should prove efficacious, it will be a great pleasure to Sir Joseph Fayrer to see the fruition of the work which he began forty years ago.

Chemical Society, May 18.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The action of nitrosyl chloride on pinene: W. A. **Tilden.** It is shown that the yield of this compound by the usual processes is improved by using a mixture of equal quantities of *d*- and *l*-pinenes. For the regeneration of pinene from the nitrosochloride, methylaniline is recommended in place of aniline.—The electrolytic estimation of minute quantities of arsenic: H. J. S. **Sand** and J. E. **Hackford.** The authors recommend the use of lead electrodes for the estimation of minute quantities of arsenic, as their application permits of a simplification of previous methods.—The action of sodium methoxide and its homologues on benzophenone chloride and benzylidene chloride, part ii.: J. E. **Mackenzie** and A. F. **Joseph.**—The bromination of phenolic compounds: J. T. **Hewitt,** J. **Kenner** and H. **Silk.** It is shown that when one molecular proportion of bromine acts on phenol, the character and proportions of the products obtained vary with the conditions under which the reaction is carried out. Absence of water and presence of a strong mineral acid favour the formation of *p*-bromophenol, whilst sodium acetate in a glacial acetic acid solution diminishes the quantity of para-derivative formed.—The decomposition of the alkylureas. A preliminary note: C. E. **Fawsitt.** An investigation of the velocity of decomposition of the alkylureas with acids shows that the hydrolysis is indirect, and is effected as a secondary reaction of the acid with the alkylammonium cyanate first formed.—The formation of periodides in nitrobenzene solution, part ii., periodides of the alkali and alkaline earth metals: H. M. **Dawson** and Miss E. E. **Goodson.** In general, these iodides have properties similar to those of the potassium derivative already described, and the experimental data indicate that enneaiodides of the type $M'I_9$ or $M''I_{18}$ probably represent the highest limiting type of periodides.—The action of ozone on ethane. Preliminary note: W. A. **Bone** and J. **Drugman.** The authors have obtained ethyl alcohol by the interaction of ethane and ozone at 100°. The paper gives an account of the method and apparatus employed.—Caproylthiocarbimide: A. E. **Dixon.** A description of this substance and of a number of its derivatives is given.

Royal Meteorological Society, May 18.—Capt. D. Wilson Barker, president, in the chair.—The principal causes of rain: the Hon. F. A. Rollo **Russell.** The chief causes of rain are only four, but several of these are often in cooperation. These causes may be briefly described as follows:—(1) the forced ascent of moist air by the slopes of mountains; (2) a mass of air invading rather suddenly another mass moving from an opposite direction and maintaining its flow below the opposing current which it displaces; (3) the ascent of more or less moist air through heavier and colder air to a height where condensation of vapour takes place, increased radiation of heat towards space, and often electrical developments producing further condensation, increase of temperature, and renewed ascent with the same results; (4) the mixture of currents of air from different directions.—On the observations of rainfall at the Royal Observatory, Greenwich, in the years 1815 to 1903: W. C. **Nash.** The author has made a full inquiry into the circumstances relating to the early history of the register, and has drawn up an authoritative table of rainfall for the long period of eighty-nine years. The average annual rainfall is 24·36 inches, and the number of rainy days 157. The greatest fall was 35·54 inches in 1903, and the least fall 16·38 inches in 1858. During the five months January to May, no monthly fall exceeding 4·37 inches was recorded, but in the remaining seven months there were twenty-four falls exceeding 5 inches. Light falls of rain are spread principally through the nine months January to September, with a decided preponderance in spring.

[1] The lancets were made by Messrs. Arnold and Sons, West Smithfield.

Anthropological Institute, May 24.—Prof. W. Gowland in the chair.—Mr. E. F. **Martin** exhibited a large collection of native objects which he had obtained during his residence in northern Nigeria. The exhibit, which was of great interest, comprised specimens of musical instruments, weapons, leather and brass work and pottery, chiefly manufactured by the Hausas.—The Rev. C. T. **Collyer** delivered a lecture on Korea and its people, which he illustrated by numerous lantern slides. Mr. Collyer, during his twenty years' residence in the country, had unrivalled opportunities of observing the Koreans, and in his lecture he gave a valuable account of their manners, customs and architecture. His slides illustrated native types and buildings, and he also explained by diagrams the plan of the Korean house, with the theoretical arrangements for separation of the sexes, their system of counting and their alphabet, which is simplicity itself, consisting of only twenty-five letters, in marked contrast to the elaborate system of ideography in use amongst the Chinese and Japanese.

Linnean Society, May 24.—Prof. S. H. Vines, F.R.S., in the chair.—Anniversary meeting. The following officers were elected:—President, Prof. W. A. Herdman; treasurer, Mr. Frank Crisp; secretaries, Dr. D. H. Scott and the Rev. T. R. R. Stebbing. The president devoted the greater part of his address to considering the life-work of Linnæus and his claim to the gratitude of later workers. The president then presented the Linnean gold medal to Dr. A. Günther.

Physical Society, May 27.—Mr. J. Swinburne, vice-president, in the chair.—The law of action between magnets and its bearing on the determination of the horizontal component of the earth's magnetic field with unifilar magnetometers: Dr. C. **Chree**. Starting with the general formula for the action between two magnets perpendicular to one another, in Lamont's first position, the author discusses how observations should be combined when the higher terms usually neglected in magnetometer reductions are taken into account.—On the ascertained absence of effects of motion through the æther in relation to the constitution of matter on the FitzGerald-Lorentz hypothesis: Prof. J. **Larmor**. In consequence of recent misapprehensions (*cf.* D. B. Brace, *Phil. Mag.*, March), the argument on this subject, as given in "Æther and Matter" (1900), is briefly re-stated. The absence of effect of convection, to the first order, was demonstrated by Lorentz. Absence of effect to the second order of the ratio of the velocity of convection to that of radiation has now been experimentally established, as regards optical interference with long path, by Michelson; as regards mechanical action on a charged electric condenser, by Trouton; as regards double-refraction, by Lord Rayleigh and by Prof. Brace. This suggests strongly a complete correspondence in detail between the material system connected with the earth's motion and the same system at rest in the æther, so that their internal relations are indistinguishable. Theoretically such complete correspondence, up to the second order, exists, involving the FitzGerald-Lorentz shrinkage, provided a purely electrical constitution of matter (as regards its physical relations) is granted, but apparently not otherwise. Thus it is held that these phenomena point consistently in that direction.—On coherence and re-coherence: Dr. P. E. **Shaw** and C. A. B. **Garrett**. In a paper in the *Phil. Mag.* (March, 1901), Dr. Shaw described a method of investigating coherence by measuring the forces required to sunder the cohered surfaces. It was there shown that forces of the order of 1 dyne were required for a copper-copper contact of two single wires. Further, there seemed to be evidence of a change of state at the place of coherence, possibly orientation of the particles at the contact. In the present paper the authors follow the same method of investigation, adducing evidence that coherence can be explained, and only explained, by Lodge's original theory of fusion, and further establishing the after-effect, whether orientation or otherwise, mentioned in the former paper.

Cambridge.

Philosophical Society, May 16.—Dr. Baker, president, in the chair.—Note on the effect of a magnetic field on the vibrations of an atom containing six corpuscles placed at the corners of a regular octahedron: Prof. **Thomson**. The Zeeman effect for a single corpuscle vibrating about its position of equilibrium is to split up the spectral line corresponding to its free vibration into a triplet, the difference between the frequencies of the extreme lines of the triplet being He/m, in a field of strength H. Measurements of the magnetic separation of lines in the spectra of various elements show that different lines may experience different separations. The object of this note is to describe a model atom the vibrations of which would not all be affected in the same way by a magnetic field. It is shown that if six corpuscles are arranged at the corners of an octahedron their vibrations will under the magnetic field be split up into three triplets; in one of these the separation of the frequencies will be normal, *i.e.* He/m, while in the other two the separation will only amount to *half* the normal value.—The effect of screening on ionisation in closed vessels: A. **Wood**. Previous experimenters have shown that the so-called spontaneous ionisation in closed vessels is in part due to a radiation from the walls of the vessels. The experiments described go to show that this radiation consists of two kinds, (*a*) a secondary radiation excited by a penetrating radiation from without, and (*b*) an intrinsic radiation probably due to a true radio-activity of the material. The former predominates in vessels of iron, zinc and tin; the latter in vessels of lead and aluminium.—Quasi radio-activity produced by the point discharge: S. A. **Edmonds**. A metallic body becomes quasi radio-active when points are made to face it, and both points and body are connected to the terminals of a Wimshurst machine, and the discharge passed in dusty air. When caused to pass in the outside air, or in air freed from dust either by settling or by filtration through glass-wool, no effect is obtainable. All metals act equally well, while the points do not become at all active. This quasi activity is considered to be due to the dust particles in the air trapping the ions present during the discharge and forming a film of them on the surface of the body.—Magnetic deflexion of the negative current of electricity from a hot platinum wire at low pressures: G. **Owen**. The paper contains an account of experiments made to obtain some information with regard to the mechanism of the discharge at low pressures. The experiments lead to the conclusion that the carriers of the current are mainly corpuscles at all temperatures. When proper precautions are taken, about 90 per cent. of the carriers are deflected by a magnetic field corresponding to that required to deflect particles for which the ratio e/m is 10^7.—Some photoelectric effects: W. M. **Varley**.—Note on the atomic weight of bismuth: R. H. **Adie**. In this note the author gave his determinations of the atomic weight of bismuth, which confirm the results of Classen and fix the value at about 208·8.—Note on compounds containing an asymmetric nitrogen and an asymmetric carbon atom: H. O. **Jones**. The investigation of the formation of compounds containing an asymmetric nitrogen atom from an optically active tertiary amine was undertaken in the hope that the two possible isomerides would be formed in unequal quantities and separable by ordinary means. This expectation has been realised for the union of methyl-*l*-amyl-aniline with allyl and benzyl iodides.—The spatial configuration of trivalent nitrogen compounds: H. O. **Jones** and J. P. **Millington**. The paper describes the results of some experiments made with the view of obtaining evidence as to the configuration of trivalent nitrogen compounds, by attempting to resolve compounds in which the valency of the nitrogen should not change during the process. Methyl-ethyl-aniline-sulphonic acid was prepared and its brucine salt submitted to fractional crystallisation, but without effecting any resolution, and similarly with the dextro-camphor-sulphonate of benzyl-phenyl-hydrazine. It is therefore concluded that the three groups attached to the trivalent nitrogen atom are normally situated in the same plane with it.—Relations among perpetuants: A. **Young**.—On the proportion of the sexes among the Todas: R. C. **Punnett** and W. H. R. **Rivers**.

Edinburgh.

Royal Society, May 2.—Prof. Geikie in the chair.—In a paper on the date of upheaval which caused the twenty-five-feet raised beaches in central Scotland, Dr. Robert **Munro** went carefully into the evidence, and gave

reasons for fixing the date of upheaval subsequent to the Bronze age and anterior to the Roman occupation.—Dr. R. H. **Traquair** exhibited a skull of the great extinct ox (*Bos taurus*, var. *primigenius*), and certain remains of reindeer, which had been found in the grounds of Dundas Castle, Dalmeny. The skull was very large, and indicated a great stretch of horns.—Prof. A. Crichton **Mitchell** gave certain preliminary results he had obtained on the rate of convective loss of heat from a surface exposed to a current of air. A thin strip of platinum foil formed the one branch of a Wheatstone bridge, which was constructed so as to be able to carry very powerful currents. The current through the strip was strong enough to raise it to the temperature of incandescence, and was measured accurately on a galvanometer placed suitably in the circuit. The strip was enclosed in a tube through which a blast of air was drawn by means of a large fan worked by a gas engine. The velocity of the air was measured directly in each case. The experiment consisted in finding the resistance of the strip, and therefore its temperature, for given values of heating current and velocity of air. It is evident that for moderate velocities of air current the strip will, for a particular value of electric current passing along it, be cooled more or less according as the air current is greater or smaller. The results so far obtained indicated that even in still air a large part of the cooling was due to convection. It was hoped that the experiments would lead to important information as to the relative amounts of convection and radiation when a surface was cooling in the air.

May 16.—Sir John Murray in the chair.—Dr. J. **Halm** read a paper on a cosmic theory of the diurnal and long-period changes of terrestrial magnetism and their possible connection with seismic phenomena and the displacement of the earth's axis of rotation. On the assumption that the atmosphere is a feeble electric conductor set in oscillation by the thermal and gravitational action of the sun and moon, an expression was obtained for the diurnal variation of magnetic potential. This contained as a factor the variation in height of a mass of air. But on the assumption that the air was in an average state of convective equilibrium, the principles of thermodynamics led to the result that this time variation in height was proportional to the time variation of the air temperature at the earth's surface. Hence was deduced the formula $V = a \sin 2\phi d\theta \ d\lambda$, where V is the magnetic potential, ϕ is the latitude, λ the longitude, θ the temperature, and a a constant. The equipotential curves so obtained showed a remarkable resemblance to Schuster's curves deduced from magnetic observations, the main difference being a lag in longitude (equal to time) of the real curves as compared with those deduced from theory. The next step in the argument was to consider the possible strains which might result from this diurnal variation in magnetic distribution, and the conclusion was that such strains would cause a slight bulging on the side next the sun. This one-sided tide agreed with the indications of the horizontal pendulum as found by Ehlert, and with the recent measurements of change of direction of plumbline. It was easy to see that the change in declination of the sun would give rise to seasonal effects, and the periodicity indicated for various latitudes agreed in a suggestive manner with the seasonal curves of seismic activity in these latitudes. By an application of the same principle of convective equilibrium, Dr. Halm showed that the daily oscillation of the barometric pressure could be represented as the sum of two terms, of which one depended on the change of temperature from the mean and the other on the second differential coefficient of the temperature at the surface. The constant factor multiplying the latter term is the same along a latitude parallel, at least to a first approximation, but the multiplier of the former term depends on the character of the locality according as it is maritime, continental, or mountainous. The general theory advanced brought into connection not only meteorological and magnetic phenomena, but also seismic activity, change of latitude, and displacement of the earth's axis, and all as a result of solar radiation acting on the earth's atmosphere. It was natural to search for the eleven-year period in these variations. A careful tabulation of Omori's recent statistics of earthquakes in Japan from the earliest recorded cases showed an undoubted eleven-year period, and gave another argument in favour of the idea that seismic activity was influenced by magnetic changes. The paper touched upon several other astronomical and meteorological problems.

PARIS.

Academy of Sciences, May 30.—M. Mascart in the chair.—The chemical effects of light. The action of hydrochloric acid upon platinum and gold: M. **Berthelot.** Pure gold and platinum are slowly attacked by fuming hydrochloric acid in the presence of light; control experiments in which these metals were treated with hydrochloric acid and kept in the dark gave no metal in solution. In the presence of manganese chloride the amount dissolved was nearly doubled.—Study of the solubility of silicon in silver. On a variety of crystallised silicon soluble in hydrofluoric acid: H. **Moissan** and F. **Siemens.** Silicon is much more soluble in fused silver than in lead or zinc. The crystallised silicon found in the solidified metal contains a certain proportion of an allotropic variety of silicon which is soluble in hydrochloric acid. The experimental results are expressed in the form of a curve, showing the relation between the total silicon dissolved as a function of the temperature, and also of that portion which is soluble in hydrofluoric acid.—On the formation in nature of vanadium minerals: A. **Ditte.**—On the use of stereoscopical images in the construction of topographical plans: A. **Laussedat.**—The effects of small oscillations of external conditions on a dependent system of two variables: P. **Duhem.**—On a phenomenon analogous to phosphorescence produced by the n-rays: E. **Bichat.** A copper plate is exposed to the action of a bundle of n-rays of definite wave-length, obtained from a Nernst lamp after refraction through an aluminium prism. The secondary rays emitted by the plate are analysed by means of a slit and an aluminium prism, making use of a phosphorescent screen. It is found that, in accordance with Stokes's law, the secondary radiations are of greater wave-length than the primary radiations from which they are derived.—Magnetic observations at Tananarive: P. **Colin.** Tables of the absolute values of declination and inclination for the year ending April, 1904.—The synthesis of a series of tertiary alcohols, starting from cyclohexanol: Paul **Sabatier** and Alph. **Mailhe.** It has been recently shown that cyclohexanol can be readily obtained in quantity from phenol by the action of hydrogen and reduced nickel. By treating with alkyl-magnesium compounds, this substance yields a series of tertiary alcohols. The mode of preparation and the physical properties of a number of these alcohols are given, the reaction appearing to proceed equally well with both fatty and aromatic compounds.—The hydrographic study of the coasts of France, from 1902 to 1903: M. **Laporte.**—On the foundations of a systematic theory of spherical functions: Niels **Nielson.**—On the universal joint: L. **Lecornu.**—On the simultaneous emission of the n- and n_1-rays: Jean **Becquerel.** From the variation in the intensity of a feebly phosphorescent screen under the influence of the n-rays with the angle at which the screen is viewed, the conclusion is drawn that under the influence of the n-rays such a screen emits n-rays normally and n_1-rays tangentially. Experiments in support of this view are given.—The action of anæsthetics on the sources of the n_1-rays: Julien **Meyer.** Sources of n_1-rays, like those of the n-rays, are affected by anæsthetics.—On a new method of obtaining photographs in colours: Auguste and Louis **Lumière.** The method described in the present communication is based on the use of coloured particles arranged in a layer on a glass plate; this is covered with a suitable varnish, and finally with a layer of sensitive emulsion. The plate thus prepared is exposed through the back, developed, and the image thus prepared inverted, giving the colours of the original photograph on looking through it.—On a new regulator allowing of the control of the vacuum in a Crookes's tube: M. **Krouchkoll.** A side tube is blown on to the bulb containing some glass wool. After the tube has become hard through use, it is only necessary to warm the glass wool slightly, when sufficient air is given off to restore the tube to its original condition.—Acetylenic aldehydes. New method of preparation; the action of hydroxylamine: Ch. **Moureu** and R. **Delange.** The acetylene hydrocarbon is heated for twenty-

four hours with an alkyl-magnesium compound. Yields of acetal amounting to about 75 per cent. of the theoretical are obtained. These acetals are readily hydrolysed to the corresponding aldehydes by dilute sulphuric acid. These aldehydes, on treatment with hydroxylamine, do not give oximes, but isoxazols, several of which are described.—The differences of histological structure and secretion between the anterior and posterior kidney in male elasmobranchs: I. **Borcea.**—On the respective functions of the two parts of the adductor muscles in the lamellibranchs: F. **Marceau.**—On the adaptation of the plant to the intensity of light: M. **Wiesner.**—On the permeability of the tegument of certain dried seeds to the atmosphere: Paul **Becquerel.** If the tegument is carefully dried, it is absolutely impermeable to the gases of the atmosphere. In the presence of moisture, however, these gases pass through. Hence the complete suspension of all the phenomena of respiration of the seed is only realised in the absence of moisture.—On the spontaneous radiations of *Sterigmatocystis versicolor*: Paul **Vuillemin.**—A case of the emission of the *n*-rays after death: Augustin **Charpentier.**—The lipolytic property of the cytoplasma of the castor-oil seed is not due to a soluble ferment: Maurice **Nicloux.**—On an albumen extracted from the eggs of the frog: J. **Galimard.**—On the condition of the starch in stale bread: E. **Roux.**—The motive action of the pneumogastric nerve on the biliary vesicle: D. **Courtade** and J. F. **Guyon.**—On the toxicity of the chlorhydrate of amylene: L. **Launoy** and F. **Billon.**—Contribution to the study of Bence-Jones albumosuria: G. **Patein** and Ch. **Michel.**—The amount of albuminoid material necessary in human diet: H. **Labbé** and M. **Morchoisne.**—On ten cases of arterial hypertension treated by d'Arsonvalisation: A. **Moutier.** In all the cases the arterial pressure was reduced to the normal. At the same time, in some of the cases, the symptoms of arterio-sclerosis disappeared in great part.

DIARY OF SOCIETIES.

THURSDAY, JUNE 9.

ROYAL SOCIETY, at 4.30.—Notes on the Statolith Theory of Geotropism. (1) Experiments on the Effects of Centrifugal Force. (2) The Behaviour of Tertiary Roots: F. Darwin, For.Sec.R.S., and Miss D. F. M. Pertz.—The Fossil Flora of the Culm Measures of North-West Devon, and the Palæobotanical Evidence with Regard to the Age of the Beds: E. A. Newell Arber.—On the Structure and Affinities of Palæodiscus and Agelacrinus: W. K. Spencer.—On the Ossiferous Cave-Deposits of Cyprus, with Descriptions of the Remains of *Elephas cypriotes*: Miss D. M. A Bate.—On the Physical Relation of Chloroform to Blood: Dr. A. D. Waller, F.R.S.—Contributions to the Study of the Action of Sea-Snake Venoms: Sir Thomas R. Fraser, F.R.S., and Major R. H. Elliot, I.M.S.—On the Action of the Venom of *Bungarus coeruleus* (the Common Krait): Major R. H. Elliot, I.M.S., W. C. Sillar, and G. S. Carmichael.—On the Combining Properties of Serum-Complements and on Complementoids: Prof. R. Muir and C. H. Browning.

MATHEMATICAL SOCIETY, at 5.30.—The Application of Poisson's Formula to Discontinuous Disturbances: Lord Rayleigh.—Some Expansions for the Periods of the Jacobian Elliptic Functions: H. Bateman.—Types of Covariants of any Degree in the Coefficients of Each of Any Number of Binary Quantics: P. W. Wood.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.—Annual General Meeting.

FARADAY SOCIETY, at 8.—The Hard and Soft States in Metals: G. T. Beilby.—The Electric Furnace; its Origin, Transformations, and Applications: Adolphe Minet.

FRIDAY, JUNE 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Rotation Period of Saturn: W. F. Denning.—Analyses of Errors of Moon's Longitude for Inequalities of Longer Periods; Methods and Results: P. H. Cowell.—Note on the Gyroscopic Collimator of Admiral Fleuriais: M. E. J. Gheury.—Variation in Latitude of the Greater Sun-Spot Disturbances, 1881–1903: Rev. A. L. Cortie.—The Mass of Jupiter, and Corrections to the Elements of the Orbits of the Satellites, from Heliometer Observations made at the Cape, 1901 and 1902: Bryan Cookson.—The Parallactic Inequality—a Reply: P. H. Cowell.—*Promised Papers*: Solar Parallax from Observations of Eros: A. R. Hinks.—Note on the Distribution of Sun-Spots in Heliographic Latitude: E. W. Maunder.—Micrometric Measures of Double Stars made with the 28-in. Refractor in 1903: Royal Observatory, Greenwich.—Sir David Gill will give an Account of the New Clock of the Cape Observatory.

PHYSICAL SOCIETY, at 8.—Projection of the Indicator Diagrams of a Petrol Motor: Prof. Callendar, F.R.S.—A Model Illustrating the Propagation of a Periodic Electric Current in a Telephone Cable, and the Simple Theory of its Operation: Prof. Fleming, F.R.S.—Exhibition of a Gyroscopic Collimator: M. E. J. Gheury.

MALACOLOGICAL SOCIETY, at 8.—On *Damayantia smithi*, Godwin-Austen and Collinge: Lt.-Col. H. H. Godwin-Austen.—Descriptions of Twenty-nine Species of Gastropoda from the Persian Gulf, Gulf of Oman, and Arabian Sea, dredged by Mr. F. W. Townsend, 1903–4: J. Cosmo Melvill.—*Conus Coromandelicus*, Sin, its Probable Affinities and Systematic place in the family Conidæ: J. Cosmo Melvill.—Descriptions of New Marine Shells from the Collection of the late Admiral Keppel: G. B. Sowerby.—Note on *Voluta brazieri*, Cox: E. A. Smith, I.S.O.—On *Doris planata* of Alder and Hancock: Sir C. Eliot, K.C.M.G.—Description of a Helicoid Land Shell from Central Australia: J. H. Ponsonby.—On Some Semi-fossil Land Shells found in the Hamakua District, Hawaii: C. F. Ancey.

MONDAY, JUNE 13.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Western Uganda: Rev. A. B. Fisher.

TUESDAY, JUNE 14.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—A New Principle in Photographic Lens Construction: Conrad Beck.

WEDNESDAY, JUNE 15.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A Direct Proof of Abbe's Theorems on the Microscopic Resolution of Gratings: Prof. J. D. Everett, F.R.S.—Report on the Recent Foraminifera of the Malay Archipelago, Part xvi: F. W. Millett.—Lecture on Nature's Protection of Insect Life, with Lantern Illustrations: F. Enock.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—Effects of a Lightning Stroke at Earl's Fee, Bowers Gifford, Essex, April 13, 1904: Rev. C. F. Box.—An Instrument for Determining the True Direction and Velocity of the Wind at Sea: A. Lawrence Rotch.

CHEMICAL SOCIETY, at 5.30.—(1) The Mechanical Analysis of Soils, and the Composition of the Fractions resulting Therefrom; (2) The Effect of the Long-continued Use of Sodium Nitrate on the Constitution of the Soil: A. D. Hall.—(1) The Decomposition of Oxalates by Heat. (2) Some Alkyl Derivatives of Sulphur, Selenium, and Tellurium: A. Scott.—The Ultra-violet Absorption Spectra of certain Enol-keto-tautomerides. Part I.: Acetylacetone and Ethyl Acetoacetate: E. C. C. Baly and C. H. Desch.—The Action of Acetyl Chloride on the Sodium Salt of Diacetylacetone and the Constitution of Pyrone Compounds: J. N. Collie.—Our Present Knowledge of the Chemistry of Indigo: W. P. Bloxam.

THURSDAY, JUNE 16.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Decomposition of Ammonia by Heat: Dr. E. P. Perman and G. A. S. Atkinson.—On Flame Spectra: C. de Watteville.—On the Origin and Growth of Ripple-Marks: Mrs. H. Ayrton.—The Influence of Rainy Winds on Phthisis: Dr. W. Gordon.

LINNEAN SOCIETY, at 8.—Variations in the Arrangement of Hair in the Horse: Dr. Walter Kidd.—An Account of the Jamaican Species of Lepanthes: W. Fawcett and Dr. A. B. Rendle.—On the Blaze-currents of Vegetable Tissues: Dr. A. D. Waller, F.R.S.—British Freshwater Rhizopoda: James Cash.—Notes on the "Sudd" Formation of the Upper Nile: A. F. Brown.—The Place of Linnæus in the History of Botany: P. Olsson-Seffon.

CONTENTS.

THURSDAY, JUNE 16, 1904.

OXFORD ON THE UP GRADE.

"You will not find your highest capacity in statesmanship, nor in practical science, nor in art, nor in any other field where that capacity is most urgently needed for the right service of life, unless there is a general and vehement spirit of search in the air."

An Oxford Correspondence of 1903. Edited by W. Warde Fowler. (Oxford: B. H. Blackwell; London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.)

OUTSIDE Oxford, the sub-rector of Lincoln College is known as a nature student—his many "Tales of the Birds" having afforded infinite pleasure to a large circle of readers, old and young, on account of their subject-matter, their truthfulness and sincerity and their great literary charm; within the university, he ranks as an authority on classical subjects. To know the views of such a man, at such a time as the present, is a matter of no slight consequence.

The booklet which Mr. Warde Fowler has most opportunely published takes the form of a series of letters exchanged between a tutor, a certain Mr. Slade, and his pupil, Jim Holmes—who, having distinguished himself by taking a second in Greats and muffed the I.C.S., goes to Switzerland on a holiday; he there falls in with two Swiss professors engaged in bug-hunting and subsequently takes a short course in architecture at Zürich under one of them. Jim is somewhat old for his age—so is Mr. Slade, for an Oxford Don, in the sense that he is far ahead of his time in the liberality of his views: but this no doubt comes of mixing with the birds. When a small boy at a private school, he tells Jim, he was what would now perhaps be called slack; he did not even play games—*but*, he read all the books he could lay hands on collected butterflies and laid the foundation of one other pursuit which had been a constant delight to him all his life since. What this was we may easily guess. He is thankful that he was a small boy then and not now. After referring to the success of several of his schoolmates, he adds:—

"I do not think we could have wasted our time altogether. Anyhow I think we went to our respective public schools with our minds fresh and our interests pretty numerous and lively. If we really were idle boys, then I think that the extirpation of the idle boy, a process on which the headmasters seem to have set their hearts, is a process that needs a little consideration and criticism."

The wisdom of this utterance is beyond question; it is undoubtedly all-important that interests should be developed in early youth and it is unfortunate that the combination of classic with naturalist is so far from being a common one; contact with nature is perhaps the most effective of all means of correcting the narrowness of outlook, the lack of alertness and of observational power, as well as the intolerable self-complacency, which, if not peculiarly characteristic, are far too often met with in the student trained on purely classical lines. Nature can be approached from so many sides, some acquaintance with scientific method can be so easily gained, that the almost complete neglect of natural knowledge by humanists, especially by the Oxford school, is nothing short of inexcusable The irrational conservatism which makes progress so difficult at the present time is probably almost wholly attributable to this neglect.

The story is opened by a letter (full of significant remarks) from Mr. Slade to Jim's father:—

"I fear Jim himself will be disappointed. . . . No one else will mind. Why it is I hardly know but it is the fact that the Greats list attracts much less general attention now than it used to . . . it may be that we don't believe any longer that a man who has taken a first is something quite out of the common. . . . I want him to get into the I.C.S. . . . but honestly I don't think he will. There's a fine quality in him which is apt to be trampled out by these elephantine examinations. . . . He would be a first-rate man for India but I doubt if they will catch him by an examination. Never mind, he will do good work in life as soon as he recovers from the effects of his education."

The kind of consolation administered to the father in this closing sentence is noteworthy. The correspondence shows how the recovery takes place—partly at Mr. Slade's hands, partly because Jim is for a time translated into an atmosphere which should but does not yet exist at Oxford.

Jim's father displays no little sanity of mind in his reply to the tutor's letter:—

"What on earth is to become of Jim if he fails—I should have thought that four years of Oxford with a little finishing at Wren's . . . would make a lad quite safe who had been in the Sixth at a public school and got a scholarship and first in Mods. However, I shall get over it and so must he; he must look out for a mastership or take to architecture like his uncle, who might take him into his office if he meant business. But that is just what Oxford men don't. The young fellows peddle along until the awful question comes down on them and then if you ask what they would like to do they say, they don't exactly know. Affairs of tremendous importance have occupied their attention—boat-races, football matches, tennis and all the rest of it—and after all it is as much our fault as yours; we like to see them enjoying themselves when they come home. And their sisters arrange an out-of-door life for them lasting pretty well all the vacation."

Jim goes to the Maderanerthal with a friend, who is soon called away, however, so that he is left with "only some stupid foreigners, professors, I fancy"; having injured his knee on the way, he is laid up there for a time. Mr. Slade sends him a parcel of books to supplement the novels in the hotel saloon—a translation of Goethe's conversations with Eckermann, Mat. Arnold's "Essays in Criticism," Gardner's "Oxford at the Cross Roads," Bury's inaugural lecture at Cambridge and Boissier's "Promenades Archæologiques." At the same time, he suggests to Jim, "Might it possibly be worth while to cultivate the acquaintance of the stupid professors?" Jim takes the fly gradually but greedily—both books and professors. The bug-hunter exhibits his catch and asks him if he knows Prof. Bolton at Oxford; of course he does not—the prophet having little honour in his own country, especially in the eyes of undergraduates, who have no love for prophets at our universities. But on

writing to his tutor, Jim asks—"Who the mischief is Prof. Bolton?"

The butterfly man, Herr Nägeli, turns out to be a doctor and, after inspecting the knee, actually goes away to fetch bandages, &c., thereby winning Jim's heart; his companion is the architect. The three soon become the best of friends.

Mr. Slade explains in due course who Prof. Bolton is—paying him the well deserved compliment of describing him as "one of the centres of gravity of the world's entomology." In this letter, he refers to Prof. Gardner as

"The Chamberlain of Oxford, who does not see why things should always go on exactly as they have done for fifty years or so and who clearly and resolutely puts out his opinion that there is room for improvement and that we must become less of a big school and more of a real University."

He asks Jim for his opinion of Gardner's book, as that of a "friendly person not wholly without intelligence" who has lately been himself through the mill which, according to Gardner, "is very much out of order and needs new scientific appliances to make it grind well." The opinion comes a good deal later: that it may be well to keep the essential principle of Greats but to adjust it to new needs, finding a way somehow to give a man a chance of keeping his kettle really on the boil.

Jim develops apace in the free Swiss air under professorial guidance. In acknowledging the arrival of the books, he confesses that he has not yet recovered the taste for reading. "I feel," he says, "with a friend devoted to natural history who complained that he had not time to read, '*for as long as there is light I want to be looking at things.*' Books may be made for men, but I deny that man was made for books."

In the next letter or two, the subject discussed is the need of treating every subject from a scientific point of view, Mr. Slade remarking:—

"It is astonishing what nonsense able men will sometimes write, just because they don't know even the elementary laws of scientific investigation." And he then dwells on the importance of attention to style in writing—of attention "to the 'ars rhetorica,' which is after all in its proper sense only the result of a conscientious effort to think clearly and get down your meaning neatly. Rhetoric need not mean adornment, though it is often used in that sense. No one would call Darwin a rhetorican, yet he was one in so far as he positively refused to let any sentence stand of which the meaning was not clear in his mind and pellucid to the reader."

Matthew Arnold is referred to on the same subject. The letter ends in a P.S., in which the following most appropriate passage from Roger Ascham's "Scholemaster" is quoted:—

"All soch Authors, as be fullest of good matter and right judgement in doctrine, be likewise always most proper in wordes, most apte in sentence, *most plain and pure in uttering the same.*"

"If I am not mistaken," Mr. Slade adds, "this would have delighted Darwin." His appreciation of Darwin is indeed very noticeable; it is much to be desired that the example which Darwin has set—his modesty, his reverence of fact and of exactness—should be brought home to humanists generally. Jim hits the nail on the head in a subsequent reply in saying:—

"I never had enough to say to trouble much about how I said it; I think that's probably the mischief rather than rhetoric—want of stuff and the necessity of writing an essay when you know nothing about the subject and care less, &c."

We seldom realise how often "want of stuff" is at the root of schoolboy failures. The discussion may be commended to the many schoolmasters who, thinking to teach English composition,[1] vainly require their pupils to write essays on subjects of which they know practically nothing and in which they cannot take the slightest interest. It is worth noting that Prof. Gardner takes up a similar attitude in his "Oxford at the Cross Roads":—

"If men were set to write out clearly what they had really learned, it would be an excellent training. But I think that to set men to write on subjects about which they know little and about which under the conditions they can learn but little is not merely inexpedient but radically immoral. It trains the writer to conceal his ignorance, to pretend to know what he does not know, to cultivate sophistries of all kinds. And worst of all, a man who has once learned the fatal art of writing plausibly, without knowledge, will scarcely in after life be persuaded to take the pains necessary in order to discover the truth of things."

We next come to a very important *dissertatio de examinationibus*. After the I.C.S. exam. Jim writes:—

"My mental liver is out of order as well as my bodily one. They do their work well at Wren's and we slaved away in the heat all day like convicts; the unlucky lecturers seem to bemoan their fate and would fain go into things a little further than they dare, but they are slaves of the lamp too—the glorious illuminating lamp of competitive exam."

In writing of his failure to pass the exam. he gives utterance to a truth which we too often lose sight of in considering examinations:—

"These . . . (adjective to taste) competitive examinations do as much harm as good by damaging more than half the competitors for no reason at all."

In his reply, Mr. Slade proceeds to "uncork himself" in a very noteworthy manner: —

"Exams there must be of one kind or another; but the less we have of exams that do not positively help us in education the better we shall be as a nation. . . . We in England have become so completely salted, soused and pickled in these exams, that we no longer use our natural intelligence in judging of them. We take them for granted and never or rarely inquire into their effect on the human mind. We have lost the power of summing up the general result of them on the nation during a long series of decades. . . . I am strongly inclined to think that our system of exams has seriously damaged the natural intelligence of the nation by almost destroying the freshness of interest which a fair average of boys ought to take in their work and by robbing them of much

[1] It is quite likely that we may progress apace. I notice in the May number of the *School World* an interesting article on the teaching of English by a master at Haileybury College—who actually urges that English boys should be taught English by much reading of English books and by speaking; who can say there is no hope for the future when such things are happening?

mental freedom and elasticity. We get into a habit of looking at knowledge in terms of examination. . . ."

The really important subject in the essay—for Oxford—is first touched upon in a P.S. by Jim, who says:—

"I have been looking into the 'Crossways' again. What does he mean when he says that everyone ought to do a piece of first-hand work? A piece of work that no one has done before? I am so ignorant that this puzzles me. Have you ever done such a thing?"

The sweet innocency of the young English graduate is well displayed in this passage. Mr. Slade is clearly cornered; he answers:—

"Excuse my saying that you are an 'enfant terrible.' You ask me if I have ever done a piece of first-hand work? . . . I decline altogether to answer the question. But I will tell you that the joy of discovering something that you did not know before is in my experience very great, and that the joy of finding that so far as your knowledge goes no one ever found it out before is far greater. I have not ever dug up anything, or caught any insect, as yet unknown to the world: but I do know how the world feels to you when you have found a new clue to an old mystery. But what Gardner meant, I think, is this: that every real student who means to occupy himself with subjects proper to a University in these days should not delay too long to try his hand at a piece of original work, suggested perhaps by a Professor or someone of real learning and certainly supervised by him: so that he may not waste time in doing what other people have done before, or in going to work the wrong way for want of knowledge of the right way to set about it. . . . The wares of German workers have become part of our stock-in-trade in Oxford and we retail them often without even marking them as 'made in Germany.' You take them all from us without questioning, without testing them, and when the examination is over you let them moulder away in obsolete note-books and sell such few books as you do possess to second-hand booksellers. Why could not *we*, too, do something in the way of investigation? No doubt some of us do, but we do it under great disadvantages, because we have no pupils who help us, or want supervision in such work themselves, and so keep us at the boiling-point. We are so many kettles that never quite get to the boiling point. . . . Yes, the tea that we make is generally weak—made with water out of kettles that have never got beyond a gentle singing on the hob. Now do you understand what Gardner wants? I daresay he is thinking of his own Archæology, in which original work and good training are essential, and more obviously so perhaps than in some classical departments: but you may take my word for it that in every department of learning the same thing holds good and that a University that does not find some room for original work, but insists upon foreign supplies, is pretty sure to lose its reputation sooner or later."

Jim settles down to work at Zürich; but somehow it doesn't seem like work: he finds that a student there *is* a student, not a gamester; and is led to believe that the professor of architecture is really keen that he should do something worth doing. His tutor, in replying, expresses his delight at hearing that he is starting work with a sense of its not being work—or at any rate grind; then he enters on a dissertation to explain why work is grind for so many Oxford men:—

"A few men," he says, "of course are 'keen,' but not nearly enough for a great University. Is it the examination system, or the charms of out-door Oxford, or national feebleness, or overwork at school (including games), dullness of lecturers, or over-conscientiousness on the part of tutors, who do so much for their pupils that they extinguish the desire, natural (I should imagine) to human beings, as to cats and dogs, to find out things for themselves? Or is it a disease accompanied by so many symptoms that it is impossible to tell which is the primary one, or where the doctor is to begin operations?"

At the end of two months Jim is sent by his professor to survey the houses in a certain district near to the Austrian frontier, to see if they are really as primitive as they are reported to be. He goes off with knapsack and camera; after a few days he returns with a number of photos, measurements and a report in English: being no longer hampered by "want of stuff" he is able to write. The reception he meets with somewhat startles him: after examining the photos for a minute, the professor embraces him; what happens as he reads the report, modesty forbids Jim to tell—but his description of the interview is none the less graphic:—

"I never yet saw a college tutor go and fetch two bottles of beer while reading a man's essay, to overcome his feelings. The fact is that the poor man does not get pupils who can write, and as I had put down exactly what I saw and what I thought to the best of my ability and in my own tongue, it was something quite new to him. We had to clink glasses so often that I began to be afraid I should be up all night and ill the next morning. . . . Before we parted he uttered these memorable words: 'You are a very remarkable young man.' No, I am not a very remarkable young man, but I have found out that I can take a tremendous interest in a bit of work when it is new and with some relation to my life's work as it is to be. And I think I can put a fair amount of intelligence into it. Is this what Gardner means by first-hand work? If so I am a convert to his views."

There is no need to point the moral of Jim's conversion: we can scarcely doubt what the result would be if professors at Oxford could be got up to the beer point of enthusiasm—many of the graduates might then "find themselves" while at the university, and would receive the most efficient preparation possible for the work of life. It is only necessary to visit, for example, the Hope collections at the museum in company with their curator to see how "a vehement spirit of search" can be developed even by the study of a few butterflies. But the iron grasp of examinations must be relaxed to make progress possible.

It is a significant fact that Mr. Warde Fowler's book should follow so closely that of Prof. Gardner—by which it is obviously inspired. We have to recollect also the correspondence on research at Oxford printed in *The Times* last summer. The "spirit of search" is clearly hovering over the university: we may hope that it will, ere long, descend upon it and dominate every branch of its work. The remarkable passage at the head of this article is printed by Prof. Gardner on the title-page of his "Oxford at the Cross Roads"; it expresses the opinion not of a writer on any branch of experimental science but of a literary authority, Mr. John Morley, being taken from his "Rousseau." It may be said without hesitation to

embody the policy which we should adopt as a national policy, which alone can give us an assured position as a nation, as we are bound to develop a forward policy.

Prof. Gardner's work is essentially a plea for the reconstruction of humanist studies—but he is not altogether free from the narrowness of outlook which is so often met with in the humanist. "If," he says, "the lead in higher education is left to Manchester or to London, the turn which it will take is probably not towards a more enlightened and scientific humanism but towards physical science. The study of nature will encroach and the study of man recede."

Whereas, however, in ancient times, the study of nature held an entirely subordinate place in the scheme of knowledge, we have now to recognise that man is but a part of nature; and since we have tamed the forces of nature to the service of man, an enlightened and scientific study of humanism is impossible without considerable knowledge of physical and biological science; it must, therefore, be the work of the universities to develop the application of scientific method to all branches of study, as humanism will suffer grievously if studied from a too narrow point of view. Matthew Arnold recognised this when he wrote:—

"The ideal of a general liberal training is to carry us to a knowledge of ourselves and the world. . . . The circle of knowledge comprehends both the study of the humanities and the study of nature and we should all have some notion, at any rate, of the whole circle of knowledge."

May the birds and the butterflies help us to sounder views!

Conduct is impaired, he says, by the want of science and culture. That our universities should hold so narrow a conception of culture as to accord a knowledge of scientific method no regular place in the curriculum is a striking commentary on the sufficiency of humanist studies as hitherto conducted.

H. E. A.

A NEW TYPE OF BOTANICAL TEXT-BOOK.

Lehrbuch der Pflanzenkunde für höhere Lehranstalten. By Dr. Karl Smalian. Pp. iii+626; illustrated. (Leipzig: G. Freytag.) Price 8 marks.

IT has become more and more clear of late years that for one man to write a satisfactory text-book of modern botany is practically an impossible task. It is true that such text-books do appear, fortunately at much rarer intervals than formerly, but they only serve to give support to this view. The well known "Bonn text-book," which has run through so many editions, is a step in the right direction, for though the whole is complete in a single volume, the authorship is composite. It cannot be long, however, before the student will finally have to give up the long cherished belief that it is possible to find within the covers of a single volume a complete manual of his subject. Dr. Smalian's volume, with its numerous closely printed pages, suggests an attempt in this direction, but an examination shows that the author has succeeded in producing a text-book of a distinctly novel type.

General and special morphology and physiology are relegated to the last hundred pages, while the whole of the rest of the book deals with the plant from what is usually termed the natural history point of view. A large number of plants, representatives of the chief natural orders, are selected, and an attempt is made to give a picture of them as living beings. Their naked eye anatomy is described, and its relation to their environment, both animal and vegetable as well as inorganic, is considered. Any special adaptations which they may exhibit are dealt with, stress being laid on their exact method of pollination, while their geographical distribution and their uses to man are also included. In many cases, to make the picture more complete, any striking animal or vegetable parasites which may seriously affect the life of the plants under consideration are figured and described. The œcological factor and the question of plant communities are always kept clearly in mind.

The descriptions of the plants are exceedingly well done, and are profusely illustrated with figures in the text, all the more important orders, both European and exotic, being dealt with, some at considerable length. Thus, under Ranunculaceæ, after an account of the external anatomy, habitat and environmental relationship of *Ranunculus acris, Ficaria verna, Caltha palustris* and *Anemone nemorosa*, no less than twelve genera are treated in detail. Furthermore, when occasion arises, other matters of general botanical interest are discussed. The Rosaceæ are an excuse for dealing with various methods of grafting; under Leguminosæ the nature of root tubercles, the morphology and function of tendrils, the movements of sensitive plants are all described. When dealing with the Horse-chestnut, the structure of the buds and their method of opening are made clear with the help of exceedingly good figures. Insectivorous plants, parasites, saprophytes, leaf mosaic, &c., are all dealt with in their appropriate places, and in considering domestic plants, such as the carrot, the striking effect on the plant of change of environment is pointed out, and a short digression made to consider the differences between mutations and variations.

The part dealing with morphology and physiology is by far the smaller portion of the book, and is of too condensed a nature to be of much value. The figures are in the main well chosen, but surely in these days of active cytological investigation of plants it is not necessary to illustrate nuclear division by a series of schematic figures drawn from an *animal* cell.

It is clear from what has been said above that the main portion of the book is literally packed with information, and certainly the author has made good the two claims in his preface, that he has given "einen reichen Stoff," and put it forward in a *readable* form. Of its value to teachers, and as a book of reference, there can be no question, and the author must be congratulated on the pen-pictures of the selected plants. But it cannot be considered satisfactory as a text-book, for its sheer plethora of facts must surely produce mental indigestion even in a subject endowed with such strong assimilating power as

the German student. Also, in a general text-book, a study of the common finer adaptations of the parts of the plant machine to one another and to ordinary conditions of environment, *i.e.* general morphology and physiology, should certainly not be sacrificed to a study of the almost endless variety of special, grosser adaptations by which plants fit themselves to special conditions of life.

The book is certainly a marvellous example of German publishing, for it has 600 pages of good paper, 597 very good figures in the text, 36 fairly satisfactory coloured plates, and the whole is well bound in serviceable and artistic cloth covers; yet the cost is only 8 marks. In no other book can so much valuable botanical information be obtained at so cheap a price.

V. H. B.

A SYSTEM OF GEOGRAPHICAL CLASSIFICATION.

Katalog der Bibliothek der Gesellschaft der Erdkunde zu Berlin. Versuch einer Systematik der geographischen Literatur. Bearbeitet von Dr. Paul Dinse. Pp. xxvii+925. (Berlin: Mittler und Sohn, 1903.) Price 12 marks.

INTENDED primarily as an index to the contents of the library of the Berlin Geographical Society, this catalogue will be of service to a far wider circle than is constituted by the members of that body. While forming probably the best guide that has yet appeared to the literature of geography in general (for few works of real geographical importance will be found to be excluded), it does a second and no less important service in the direction of a classification of geography, a service of especial value in the present stage of the development of the science.

Dr. Dinse, who is himself both a geographer and librarian, has evidently bestowed much thought and pains on the elaboration of the system adopted, and the general result is thoroughly satisfactory. The whole arrangement of the body of the work is a subject one, all the purposes of an authors' catalogue being at the same time supplied by the alphabetical index, which has been kept within small compass by a judicious abbreviation of titles. In the rest of the work the compiler has wisely eliminated the alphabetical arrangement, the fetters of which too often mar the usefulness of attempts at subject classification. Two main divisions are laid down at the outset, the first concerned with the wider and more general aspects of geography, the second with the topographical subdivisions of the earth's surface. A glance at the schedule of classification for the former category shows in a striking way the great development of geographical science within recent years, the subject-matter being divided into no fewer than eleven main divisions, most of them in turn subdivided into groups of the second, third or fourth order. It may possibly be thought that this minute subdivision militates against facility of reference, as few bibliographical items are of so restricted a scope as to belong definitely to one ultimate subdivision only. But this objection has to a certain extent been met by a duplication of entries. Of the eleven main headings, that denoted "general physical geography" is naturally the most comprehensive, while of its eight subdivisions, the last, or "geomorphology," is perhaps the most important as dealing with what may be regarded as the kernel of the whole science. On the whole, the groups are logically and clearly defined, though it is perhaps inevitable that the boundaries should occasionally lack this character of precision. It is not easy, *e.g.*, to draw a hard and fast line between geophysics and geomorphology, for both seismology and vulcanism might, from one point of view, be rather grouped with the former than (as is done by Dr. Dinse) with the latter. Again, the reason for the order adopted is sometimes not quite apparent. Thus historical topography (Länderkunde) seems separated by a needlessly wide interval from the history of geographical science in general. But such difficulties are no doubt inseparable from any attempt at a linear arrangement of mutually inter-related groups. In the topographical section political divisions are necessarily taken as a basis, but others of a more elastic nature, in part based on physical factors, have been wisely introduced alongside of the former.

It should be mentioned that the catalogue deals not with books only, but with the contents of a certain number of series or collections, besides including the titles of a large number of separate copies ("Sonderabdrücke") of articles in geographical periodicals.

E. H.

OUR BOOK SHELF.

The Sporting Dog. By J. A. Graham. American Sportsman's Library. Pp. x+327; illustrated. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1904.) Price 8*s.* 6*d.* net.

QUITE apart from its interest to the class for whom it is primarily intended (and to whose requirements it appears in every way admirably suited), this volume appeals strongly to the naturalist and to the student of variation. Despite certain pretensions (of which the author makes very short work) of some of them to derivation from "native breeds," American sporting dogs, other than mongrels, are admittedly derived from English stocks, but their new environment, and the different conditions under which they are employed, have in all cases, except that of the greyhound, caused them to display considerable variation from the parent type. It is the author's description of these variations which will cause his volume to have a considerable interest and value to the naturalist.

"It is foxhounds and shooting dogs," writes Mr. Graham in his introductory chapter, "which have become, under American conditions, something essentially different from what the British sportsmen established and have maintained as filling their conceptions of utility and good looks. Reduced to the simplest terms, the change wrought over here comes to this: the dry climate of extreme temperatures, the nature of the ground and game, and the methods of hunting the fox and shooting game birds cause the survival of the fittest to proceed in the direction of a faster, lighter, more enduring animal; perhaps not more sensitive of nose, but quicker in the reflexes of judgment and action which are the sequences of scent."

In a word, pace and the capacity to act on his own initiative, rather than as a member of a pack, are the

essential features of an American foxhound, while among pointers (which are special favourites in America) and setters a greater proportion of energy to weight is the feature at which the breeder aims. The admirable reproductions from photographs with which the excellent little volume is illustrated fully bear out the author's statement as to the marked physical differences of the dogs he describes from their European prototypes. R. L.

Histoire de l'Habillement et de Parure. Bibliothèque scientifique internationale. By Louis Bourdeau. Pp. 302. (Paris: Félix Alcan, 1904.) Price 6 francs.

THE history of clothing and of ornaments is an important aspect of the history of culture, and it well deserves independent treatment. M. Bourdeau deals with the primitive articles of clothing, skins, natural vegetable products and the like, the method of working these, and the fabrication of textiles and the methods of colouring them. The making and wearing of clothes are briefly noted with the history of costumes, in which are included dressing the hair, head, hand and foot gear, umbrellas and jewellery. The scheme is good enough, but, as the work is confined to 299 pages, the treatment is necessarily slight, for the author begins with Genesis, quotes Greek and Roman authors, and, glancing at intermediate periods, finishes with modern industrialism, making allusions by the way to non-European peoples of varied culture.

The book can be recommended to those who require a light, popular sketch of the history of clothing—the serious student will, however, be disappointed. The author's knowledge of ethnology appears to be extremely limited, judging from the imperfect statements in, and the omissions from the book; for example, the paper mulberry tree is not mentioned; he is unaware of the practice of the Roman Catholic women of Bosnia and Herzegovina to tattoo themselves so as to be further discriminated from the followers of Islam; like most other writers, he does not distinguish between the Maori *moko* and ordinary tattooing. No mention is made of the production of patterns in cotton fabrics by tightly tying several strands of a warp in different places and then dyeing the whole, which technique is carried to a high degree of excellence by many Malayan peoples; nor is the analogous method of waxing fabrics and dyeing the unwaxed portions referred to. Melanesians are confounded with Polynesians (p. 229), an error as great as speaking of Negroes as Europeans. But it is in the section on ornaments that the author is weakest. It is now well recognised that what are generally spoken of as "ornaments" are worn by nature-folk and by barbarians for magical purposes as prophylactics to ward off evil, to ensure good luck generally, or to produce some definite result. This aspect is entirely ignored by M. Bourdeau. Many "ornaments" have the value of currency, but probably very few are worn solely for purposes of adornment. There are no illustrations, and, as is usual with this class of book, there is no index.

The Ether: Some Notes on its Place in Nature. By John Rhind. Pp. viii+87. (Wick: W. Roe, 1904.)

LIKE the mythical Dog Diamond, Mr. Rhind little knows what mischief he is doing. If his amendments of accepted beliefs were adopted, the well built doctrine of science would become no better than

"a tale told by an idiot,
"Full of sound and fury, signifying nothing."

Mr. Rhind's knowledge of principles goes no deeper, apparently, than the most popular utterances of popular lecturers and writers, and these are subject to amendment *ad libitum* to square with "common sense." With this slender equipment he does not falter to lay violent hands upon the theory of gravitation, the conservation of matter, and the nebular hypothesis.

A single example (p. 45) of the method will suffice:—"We would suggest that the earth may have the power of converting, or in other words of condensing, the ether into oxygen, which is the principal agent in sustaining life. The sun's atmosphere being so much more powerful, will be able to condense this element into an electric fluid which, being sent to his planets, gives them light and heat, and in combination with the oxygen of our earth and its atmosphere completes the power, if not of introducing life, of maintaining the life that already exists on our globe." It seems that (p. 48) "ether, oxygen and the electric fluid are only different manifestations of the same substance." The moral of the book appears to be that if science were adequately taught us at school, a gentleman with an active and spontaneous interest in natural phenomena need not in after life go so pitifully astray.

A Safe Course in Experimental Chemistry. By W. T. Boone. University Tutorial Series. Pp. vi+180. (London: W. B. Clive, 1904.) Price 2*s.*

THIS little volume is quite up to the standard of the best of modern elementary books on practical chemistry. It clearly embodies the experience of a thoughtful teacher who has made his students work and think accurately, and is not without originality of treatment in the arrangement and character of the exercises.

It has the fault of all experimental books which ignore the presence of the teacher, inasmuch as it is forced to supply wordy and involved descriptions of such simple operations as, for example, removing a stopper when using a stoppered bottle, which a demonstration would make clear in a moment.

One of the "rules for a chemical laboratory" laid down at the beginning of the book—"do not use more of a reagent than is necessary"—raises an obvious question which might be difficult to answer at this early stage, and is rather like telling a child not to eat too much.

The use of the word "safe" in the title conveys a flavour of quackery, which is a little unfortunate in a book of much solid merit. The illustrations serve their purpose, no doubt, but the handiwork of the amateur is a little too evident.

Apart from these few criticisms, the book, as already stated, deserves a good reception. J. B. C.

Catalogue of British Coleoptera. By T. Hudson Beare, B.Sc., and H. St. J. K. Donisthorpe, F.Z.S. Pp. 51. (London: Janson, 1904.)

THIS is one of the lists which are imperatively required by students of British entomology to keep them informed from time to time as to what species are actually considered by good authorities to be found in these islands, genuine additions being allowed for, and doubtful records eliminated. The print is clear and good, and another edition on stout paper, and printed on one side only, to be used for labels or notes, has been issued. The authors' names are a sufficient guarantee for the care and accuracy with which they have apparently done their work. The list contains 3274 species admitted as indigenous, and there are supplementary lists of introduced or doubtful species. The introduced list is headed by two very conspicuous species, which, though not unfrequently taken in England, can hardly be considered indigenous. These are *Carabus auratus* (often introduced with vegetables, &c.) and *Calosoma sycophanta.*

The last critical list of British beetles, by Sharp and Fowler, was published eleven years ago, and we heartily recommend the present list to British entomologists.

A Preliminary Course of Practical Physics. By C. E. Ashford, M.A. Pp. 48. (London: Edward Arnold, 1904.) Price 1s. 6d.

THIS little book on practical physics is of a kind familiar to teachers of the subject. The experiments are simple and well within the power of schoolboys, but so far as we have examined them they differ little from those to be found in well known books. Indeed, in his preface the author says it is impossible adequately to acknowledge the debt "to those from whose books many of the experiments have been derived." But though the book contains much in common with previously published first courses of practical physics, the author has compiled a logical and useful manual of experiments which will serve to introduce boys to the study of physical science. The volume may be recommended to the attention of teachers deciding upon a book to place in the hands of their pupils.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Radio-activity of Natural Gas.

IN a paper by Mr. E. F. Burton, recently published in the *University of Toronto Studies, Physical Science Series*, an account is given of some experiments with a highly radio-active gas obtained from crude petroleum. In this investigation it was found that air drawn through crude petroleum became charged with a radio-active emanation which, from the rate at which its activity decayed and from the nature of the induced radio-activity which it produced, the author concluded to be an emanation from radium.

The present writer has extended this investigation to an examination of the natural gas from different wells in western Ontario. The gas from every well examined, which included those in the Welland district, in the neighbourhood of Niagara Falls, as well as those near the city of Brantford, was found to be charged with a radio-active emanation. The activity of this emanation in all the gases tested was found to decay or die out to one-half its original intensity in about three days, and the intensity of the induced radio-activity which it produced died down to one-half value in about forty minutes.

The wells examined varied in their depths, but the amount of active emanation present was found to be practically the same in all wells coming from the same horizon. In the Welland district, the gas from those wells which had their source in the stratum known as the Niagara formation, and which were about 500 feet deep, possessed the highest initial conductivity. On an arbitrary scale this conductivity is represented by about 2000.

The gas of those wells which had their source in the Clinton limestone, 750 feet deep, possessed an initial conductivity of about 300 on the same scale, while that from wells coming from the Medina formation, about 900 feet deep, gave an initial conductivity of about 1200. One well, which had its source in the Trenton limestone, and had a depth of about 3000 feet, possessed an initial conductivity of about 200. The highest conductivity obtained in the investigation was that of the gas from a well near the city of Brantford, the conductivity in this case being about 9000. An investigation of this gas showed that, under the action of the emanation with which it was charged, there was produced, at normal pressure, about 15,000 ions per second in each cubic centimetre of its mass.

A test made on the conductivity of ordinary air, confined at atmospheric pressure in the receiver used in making the measurements on the conductivity of the different samples of natural gas, showed a production of 32 ions per cubic centimetre per second. J. C. MCLENNAN.

University of Toronto, May 28.

The Source of Radio-active Energy.

IN NATURE of June 2, Mr. Jeans brings forward the view that the energy manifested in radio-active processes is derived from the coalescence of positive and negative ions, thus involving an annihilation of matter. For some time it has seemed to me that some such fundamental change is needed to account for the observed phenomena, and I therefore venture to submit some general and numerical considerations bearing on this view.

Mr. Jeans is inclined (as I understand) to attribute the beginnings of the process to a change of type in advancing æthereal waves, arising from a lack of strict linearity in the equations of the electromagnetic field. It may be pointed out, however, that whether or not the circumstances of æthereal wave-propagation are strictly expressible by linear equations, there is a *universal tendency* towards loss of kinetic energy in orbitally moving systems of electrons. Unless the orbital periods are very long compared with the time taken by radiation to traverse the assemblage, there must be appreciable radiation of energy, and it is thus a necessary condition of permanence or quasi-permanence that *the orbital velocities should be very small compared with the velocity of light.* This view is confirmed by numerical consideration of simple cases in which the orbits are assumed to be of *atomic* dimensions; it is also borne out by the general optical properties of matter.

It should be remarked that as energy is dissipated and orbits become contracted, with corresponding rise of velocities, the total effective radiation will become more and more intense, so that conceivably very little time may be occupied in the transition from a quasi-permanent motion to a state of collapse and disintegration; indeed, once the orbital motions have begun to give out perceptible radiation, the life of the system must be excessively short.

Thus, whether we look for the main source of radio-active energy in enormous orbital velocities due to intra-atomic rearrangement, or in the constitutive electrostatic energy of individual electrons set free by mutual annihilations, the conditions favourable to radio-activity in any given atom must be confined to a momentary phase—momentary, that is, as measured by ordinary standards. It is not a long step from this conclusion to an exponential law of decay of radio-active matter.

If we adopt provisionally Dr. H. A. Wilson's very interesting suggestion (NATURE, June 2) that, the positive and negative electrons having numerically equal charges, the greater mass of the positive electron is due to its smaller diameter, it follows that *any* isolated electron has electrostatic energy $=\frac{1}{2}m.3V^2$, where m is the mass of the electron (when moving slowly) and V is the velocity of light. In other words, when matter of mass M is annihilated, energy $=\frac{1}{2}M.3V^2$ is set free—initially as an electromagnetic pulse of great intensity. *A further assumption involved in this estimate is the validity of the ordinary electrostatic-field relations for such enormous intensities as obtain in the neighbourhood of an electron.*

If annihilation of matter furnishes the energy of radio-activity, it follows from our estimate that, in the case of radium, the coalescence of one pair of electrons causes the break-up of a large number of radium atoms (something of the order of one hundred), otherwise the total energy emitted by radium would be much greater than that which has been observed by Curie and Laborde.

If the assumption in italics above is very wide of the mark (which is conceivable), our estimate of the energy of annihilation is probably in excess.

It may be supposed that some neighbouring atoms, which are not actually broken up by the pulse arising from a pair of coalescing electrons, receive a sufficient access of kinetic energy to *prolong* their existence. "Metabolons" of short average life may be conceived of as consisting of assemblages the orbital motions of which are especially liable to be damped out rapidly by radiation of energy.

Cambridge, June 9. C. V. BURTON.

NEW LAND.[1]

On June 24, 1898, a vessel, insignificant in size and somewhat quaint in appearance, unlike ships generally engaged in ordinary mercantile avocations, might have been seen threading her way, under her own steam, through the numerous merchant ships that were at anchor in the harbour of Christiania. She was a vessel of no common type; her peculiarities of construction and rig were noticeable, even to the inexperienced eye of a landsman, and judging from the enthusiastic cheers with which she was greeted on all sides, she was evidently bound on a voyage of no common interest. The ships in harbour were all decorated with gay bunting; flags flew from their mastheads, and cheer after cheer resounded from their crowded decks and rigging as she steamed slowly past. The quays and wharves along the shore were also thronged with a vast concourse of people, bedecked in their smartest and gayest holiday attire, all equally enthusiastic in their demonstrations of farewell, while the fjord itself was alive with innumerable boats of all descriptions, including many small steamers, all intent upon one object, namely, to do honour to the little vessel that was so quietly proceeding to sea, and to wave her a last good-bye.

What was the cause of all this enthusiasm and excitement? and why was this little craft the centre of so much attention and attraction?

A glance at the name on her stern revealed the fact that she was the *Fram*, and that she was bound on an important voyage of geographical exploration and scientific research in high northern latitudes.

She was the same little *Fram* that was specially designed and constructed for Dr. Nansen in 1892, and had carried that bold explorer northwards on his memorable and adventurous voyage towards the North Pole. His second in command, and navigating officer, on that occasion was Otto Sverdrup, an officer of the Norwegian mercantile marine, who had been specially selected for the appointment in consequence of the experience he had gained in ice navigation while serving as a mate on board a Greenland whaler.

It was the same Otto Sverdrup who was in command of the little *Fram* as she steamed out of Christiania Harbour on the occasion to which we refer, but in this instance he was not only commander of the ship, but was also the leader of the expedition. He had already won his laurels as an Arctic explorer, and had proved himself a careful, as well as a skilful, navigator in ice-encumbered seas. His selection for the command of the *Fram* was more than justified, as a perusal of his account of the voyage, which has recently been published under the title of "New Land," will abundantly testify. The book, originally produced in Norway, has been well and ably translated into English by Ethel Hearn. The narrative of the cruise is presented to us in the shape of two handsomely bound volumes, profusely illustrated from sketches and photographs taken by members of the expedition. It is perhaps unfortunate that a great many of the illustrations in the text are not inserted on the pages to which they refer, but this does not detract from their excellence. The story as related is the plain unvarnished tale of a sailor; the incidents are graphically described, and a vein of humour pervades the whole narrative.

The Introduction informs the reader very curtly as to the origin of the expedition, and how it was that Otto Sverdrup was selected as leader. He writes :—

FIG. 1.—Seventeenth of May, 1899. From "New Land," by Otto Sverdrup.

[1] "New Land. Four Years in the Arctic Regions." By Otto Sverdrup. Translated from the Norwegian by Ethel Harriet Hearn. 2 vols. (London: Longmans, Green and Co., 1904.) Price 36s. net.

"A few days after our return from the first Norwegian Polar Expedition, we were lying in Lysaker Bay unloading the *Fram* when Dr. Nansen came on board. 'Do you still wish to go on another expedition to the North?' he asked me.' 'Yes, certainly,' I answered, 'if only I had the chance.' He then told me that Consul Axel Heiberg,[1] and the firm of brewers Messrs. Ringues Brothers,[1] were willing to equip a new scientific expedition with myself as leader."

The Norwegian Government, realising the value of the work it was proposed to carry out, in a truly patriotic spirit well worthy of emulation, placed the *Fram* at the disposal of the promoters of the enterprise, and generously added the sum of 1100*l.* to assist in defraying the cost of the expedition. The main object was the exploration of the north coast of Greenland by way of Smith Sound and Robeson Channel, in fact, to follow in the footsteps of Nares's expedition

FIG. 2.—Sledging expedition ready to start. Spring, 1901. From "New Land," by Otto Sverdrup.

in 1875; on reaching the highest point attained by our countrymen on the north coast of Greenland, the explorers were to continue along the coast, and as far to the east as it was possible to reach—in other words, to determine by actual exploration the insularity of Greenland.

There was to be no question of trying to reach the North Pole!

In the event of unforeseen difficulties interfering with the successful accomplishment of this project, Captain Sverdrup was at liberty to use his own judgment and discretion in formulating a revised programme that would, in his opinion, be the best to further the interests of geographical exploration and other scientific investigations.

The liveliness of the little *Fram* during the first few days in the Atlantic, when somewhat stormy weather was encountered, is thus jocosely alluded to by the author:—

"The members of the expedition, who were not much used to the sea, turned very white, and looked extremely serious. They trooped to the doctor and complained of various symptoms; some had headache, some shivering fits, and some pains in the stomach, which they had contracted, they knew not how; but none of them mentioned the malady by its right name. The doctor, however, came to the conclusion that the complaint with the many different aspects, had a single and fairly simple name, to wit, sea sickness; and for it there was but one and an equally simple remedy, dry land. Unhappily we had forgotten to bring any with us in our otherwise so well equipped Expedition, but it was hoped it might be found somewhere north in the Arctic Ocean, and this appeared to console the sufferers."

Time, however, as is usual in similar cases, soon restored the ailing ones to their customary health and the free use of their sea-legs! The complement of the little ship was, exclusive of the captain, only fifteen souls. In this small number was included two deck officers, a doctor, cartographer (who, by the way, was a cavalry officer), botanist, geologist, zoologist, two engineers, a steward, and four others who made themselves generally useful in carrying out any duties that might at any time be apportioned to them. All, it is almost unnecessary to add, assisted in the working of the ship when at sea or in the ice.

On reaching Smith Sound, their further progress north was effectively barred by an impenetrable ice pack. After several unsuccessful attempts to push through, they were at length compelled to go into winter quarters, on the west side of Smith Sound, not very far from its entrance, in a small partially

[1] These gentlemen had contributed largely in assisting to defray the expenses of Nansen's expedition!

sheltered bay, which they appropriately named Fram's Haven.

The winter passed pleasantly. They were fortunate in securing abundance of fresh meat in the shape of musk oxen, hares and ptarmigan, while they were also lucky enough to kill several walruses, which afforded them an excellent opportunity of laying in a large stock of food for their dogs, of which they had about seventy on board.

It is a pity that Captain Sverdrup in his narrative should have considered it desirable to alter the nomenclature of that animal which has so long, and so universally, been known as the musk ox. Its scientific name is the *Ovibos moschatus*, and it was so called in consequence of the musky odour which has always been associated with its flesh. Captain Sverdrup, simply because he failed to detect this strong scent in any of the beasts killed in his expedition, somewhat arbitrarily alters the name by which they have hitherto been known to that of "polar ox." This is a misnomer, for although the animals have been found in a fairly high northern latitude, they are also inhabitants of sub-Arctic climes, and are frequently seen as far south as latitude 54° in North America.

It is an established fact, although not, apparently, coming under the personal cognisance of Captain Sverdrup, that unmistakable traces of the odour of musk, which have had most unpleasant effects on those who have partaken of the meat so tainted, have on many occasions been observed by travellers and explorers, who, however, also report that their flesh when not tainted is excellent eating.

It is therefore to be regretted that Captain Sverdrup should have so completely ignored the experience of others, and substituted another name for an animal that is so well known, and one which has been in general use for so many years.

During the winter and following spring, several sledging expeditions were undertaken, having for their object the exploration of Ellesmere Land.

On one of these excursions Captain Sverdrup was unlucky enough to break one of his teeth, which incident is thus somewhat facetiously alluded to.

"When dinner was at last served, I fell to on a biscuit with such ardour that I managed to break off a front tooth. Fosheim (his companion) thought we ought not to waste our teeth so far away from people, and implored me not to go on in that way. I followed his advice, and was about to throw away the tooth, when he again observed, that there was no knowing how useful it might be; so I put it in my pocket to serve as a remembrance and a warning. I have since had it put in again."

Fosheim was evidently a man of a practical turn of mind, thoughtful, sensible, and of great perspicacity!

Although the Eskimos have never yet been found living on the western side of Smith Sound, vestiges of a previous occupation of the country by these nomadic tribes were discovered. They consisted chiefly of little heaps of stones and the ribs of whales placed in circular formations, presumably so arranged as to form their summer encampments. Similar traces, it may be remembered, were found by Sir George Nares's expedition on the west side of Smith Sound.

During one of his sledging expeditions in the late autumn, Sverdrup was startled by the altogether unexpected arrival at his camp of a sledge with two men on it. They proved to be the American explorer, Commander Peary, with an Eskimo dog driver. They had driven over from the ship *Windward*, which was beset in the ice about a mile from the shore in the neighbourhood of Cape Hawks.

This meeting on the silent shores of the Arctic Ocean seems to have been as surprising and as unexpected as the equally strange one between Nansen and Jackson in Franz Josef Land only a couple of years earlier. At that time they were probably the only two expeditions in the Arctic regions engaged on geographical discovery. They had been absent from home for a long period; they were several miles from their respective ships, yet we read, with something akin to surprise, that Peary only remained in their company for a few minutes, and would not even wait while a cup of coffee was being prepared for him, or, as Captain Sverdrup tersely puts it, "his visit was so short that we had hardly time to pull off our mittens"!

In the spring of 1899 the *Fram* was visited by several Eskimos from the east side of the Sound who were on their way to Peary's ship. They were so pleased with the warm reception that was accorded them, and with the kindness they received at the hands of the Norwegians, that they appear to have overstayed their welcome, for we read that:—

"We began to be heartily sick of them all. They spread all over the vessel a peculiar rank odour of blubber and train oil with indefinable additions. We tumbled over them wherever we went, while their shock heads of hair looked as if they might accommodate a legion of animals of which we stood in far greater fear than of either the polar ox or the bear"!

The wandering Eskimo is not altogether the most agreeable or the most savoury companion to associate with for an indefinite period.

It was not until the end of July that the *Fram* succeeded in extricating herself from the icy bondage in which she had been held for eleven long months. Attempts were at once made to work to the northward, but the ice was found so tightly packed that Captain Sverdrup abandoned all further efforts to proceed in that direction, and turned his attention to Jones Sound, a route that had always been regarded by Arctic authorities as one very favourable for exploration. On September 1 the *Fram*, having reached a position (in this sound) in the neighbourhood of Admiral Inglefield's furthest in 1852, was secured in her second winter quarters, in a small and almost land-locked harbour which was named Havnefjord.

From this position much useful and important geographical work was accomplished by boat in the autumn, and by sledges during the following winter and spring. Many musk oxen were fallen in with, and a large number of seals also were shot. The cold during the winter was so great that the brandy in a flask was frozen solid. The following little episode will show that inconveniences arising from intense cold were not regarded in a very serious manner by the travellers:—

"While Fosheim was taking his turn at running, being as warm as possible, he forgot all about his nose, which took this opportunity of freezing. He knew nothing about it, until it was frozen so stiff that it looked like a piece of white bone in the middle of his face, and he might easily have broken it off. Had it gone on freezing a little longer, he would have been noseless.

"However with general assistance and careful treatment that member was saved at the last moment, but it wore mourning for a long time afterwards, and looked more like a dab of pitch which had got into the wrong place than anything else in the world."

When released in the summer of 1900, the *Fram* steamed to the west and went up Cardigan Strait; after being beset in the ice for some weeks they succeeded in reaching the head of Goose Fjord, where they passed their third winter. They confidently expected that this would be their last winter from home; but, alas! the Fates ordained otherwise, and they were compelled to pass a fourth one, having only succeeded in

advancing during the summer a distance of nine miles, which brought them within five miles of the open water and freedom! It was, indeed, tantalising to know that such a short but impenetrable barrier intervened between them and the open sea. It will be remembered that it was exactly this distance of land ice that prevented our own ship, the *Discovery*, from being liberated after her first winter in the Antarctic regions.

In spite of their disappointment, the brave Norwegians did not in any way relax their efforts to carry out the important work entrusted to them, and much valuable information in various branches of science was obtained during their long sojourn in Goose Fjord, one of the sledging expeditions having attained the high latitude of 80° 30′, almost succeeding in reaching and joining hands with Aldrich's furthest in lat. 82° 16′ and long. 85° 30′ W. on the north coast of Grinnell Land.

It was August, 1902, before the little *Fram* was released from her imprisonment, reaching Norway the following month, where the gallant explorers received after their long absence that hearty welcome, not only from their own countrymen, but from the civilised world at large, which they so richly deserved.

On the whole the expedition achieved a great success. It added very materially to our geographical knowledge of the Arctic regions, especially in the neighbourhood of the Parry Archipelago. Captain Sverdrup cleared up satisfactorily the debatable question as to whether Hayes Sound had an outlet to the west, or whether it was, as many thought, only a large bay. The western limits of Ellesmere Land, Grinnell Land, and Grant Land were determined, a matter of some geographical importance, as illustrating the archipelagic character of the land on the western side of Smith Sound and Robeson Channel.

The scientific work accomplished by the expedition is contained in four appendices at the end of the second volume. Appendix i. relates to the geological investigations made during the voyage, and is of great interest. Appendix ii. is a summary of the botanical work of the expedition and its results. Appendix iii. refers to the fauna of the different localities visited by the explorers. The scarcity, it might almost be said the extinction, of the reindeer is ascribed to wolves; these voracious animals are the great enemies of all Arctic quadrupeds, except, perhaps, the polar bear and the musk ox. Four species of butterflies were found, as well as some moths and a few wasps.

Appendix iv. refers to the meteorological observations regularly taken during the whole four years.

Much literary skill is exhibited by the author in the compilation of this work. It is written in a popular manner, and imparts valuable information in an interesting and pleasing way.

It is a book that will certainly take its place among other standard works on the Arctic regions.

An excellent map of the regions explored will be found in a pocket at the end of the second volume.

AN IMPORTANT ARCHÆOLOGICAL DISCOVERY IN EGYPT.

THE most important archæological event reported from Egypt during the last excavation season (1903–4) is the discovery by Prof. Naville, of the University of Geneva, and Mr. H. R. Hall, of the British Museum, of the most ancient temple at Thebes. The excavations were carried on by Messrs. Naville and Hall on behalf of the Egypt Exploration Fund, which is to be congratulated on having made this important discovery. The services which have been rendered by the Egypt Exploration Fund to Egyptological science since its foundation, some twenty years ago, have indeed been innumerable.

One of the most important works carried out by the fund was Prof. Naville's complete excavation of the great temple of Deir el-Bahari, in the western hills of Thebes. The excavation came to an end in 1899, after the main temple had been entirely cleared and the necessary works of conservation and restoration had been carried out, but before the environs of the temple had been completely explored. To the south of the temple lay a wilderness of rubbish heaps, which might conceal a necropolis or even another temple, placed between the great shrine built by Queen Hatshepsut and the southern horn of the *cirque* of cliffs which rise behind and around Deir el-Bahari. Means for further excavation failed, however, and the exploration of the unexcavated tract to the south of the temple was postponed until the present season, when Prof. Naville again took up the spade and very soon discovered that underneath the heaps of rubbish (Fig. 1) lay the not inconsiderable remains of a smaller temple, of high archæological importance on account of its age.

FIG. 1.—Excavators at work on the Mounds.

It is the funerary temple or mortuary chapel of the most distinguished monarch of the eleventh dynasty, Nebkherurā Mentuhetep, who reigned about 2,500 B.C., according to the best authorities. A temple of this date is a great rarity in Egypt. Remains of even older ones (of the same funerary character) have been found by the German excavators, Messrs. Borchardt and Schäfer, at Abusir, near Cairo; these belong to the fifth dynasty and are at least five hundred years older than Prof. Naville's new temple; they are the most ancient temple remains in Egypt. The new temple, however, comes next to them in age, and if it is surpassed by them in peculiarities of architecture, it appears to fully equal them in general architectural interest and to surpass them in the point of artistic interest and importance, since it has added considerably to our knowledge of the history of Egyptian art.

The artistic triumphs of the Old Empire are well known; but our knowledge of the condition of art at the beginning of the Middle Empire under the eleventh dynasty was, until the present discovery, scanty. The general impression has been that the work of the

eleventh dynasty was rough and crude in style. The discovery in the new temple at Deir el-Bahari of hundreds of fragments of coloured relief sculptures of the eleventh dynasty compels us to modify this impression, and we see from them that, side by side with the somewhat crude and awkward productions hitherto considered characteristic of this dynasty, work of the highest excellence was also turned out. This is an important result, and it is by no means improbable that this improved artistic style is the work of a sculptor who, we know, lived in the reign of Nebkherurā, Mertisen by name, and his school.

These reliefs originally formed part of the decoration of the walls of the main pillared hall of Nebkherurā's temple. This hall, only a part of which has as yet been uncovered, stands upon an artificially squared platform of rock, immediately to the south of the Hathor shrine of the great temple of Deir el-Bahari, and separated from it by a small open court about sixty feet across. The platform is about fifteen feet high. Its sides were masked by a magnificent wall of finely-squared and fitted limestone blocks, built in bonded courses of

FIG. 2.—The Granite Threshold and Pillared Hall.

broad and narrow blocks alternately, one above the other, as may be seen from the photograph. In the extreme south-west corner of the court this wall is perfect. It is without doubt one of the finest specimens of Egyptian masonry yet brought to light. Entrance to the main hall on the platform was gained, as in the great temple, by means of an inclined ramp, which led up to an entrance gate, no doubt, like that of the main temple, a trilithon of red granite; the threshold of finely-polished red granite still remains *in situ* (Fig. 2). The socket in which the door turned (in the usual ancient manner before the invention of the hinge) is clearly seen, and also the small side run, or channel, by which the door could be bodily removed from the socket and replaced when necessary.

To the north of the ramp a colonnade of small, square sandstone pillars has been discovered, placed on a stone pavement immediately before and below the platform. It can hardly be doubted that a second similar colonnade originally existed to the south of the ramp. Thus we have the main portion of the temple, consisting of a pillared, or "hypostyle," hall of octagonal pillars placed on a platform of rock, approached by an inclined ramp, flanked by colonnades on the lower ground level. It will be noticed by all who have visited Deir el-Bahari that, so far as platform, ramp, and colonnades are concerned, this is precisely the arrangement of the great temple of Queen Hatshepset, or Hatasu, to the north. This opens up a new field of possibilities. The curious plan of the great temple has puzzled archæologists and architects from Wilkinson's time to the present day. Whence this curious arrangement of platforms, inclined planes, and colonnades, so totally unlike anything else in Egypt? Various theories have been propounded, but it is only now that the solution has been found, owing to the discovery of the temple of Nebkherurā. Colonnades, platforms, and ramps are then a feature of the older temple-architecture of Egypt; they were, at the time of the eighteenth dynasty, when the great temple of Hatshepset was built, old-fashioned, archaic, but it is evident that the great temple is, as far as its main arrangements are concerned, a mere enlarged copy of the thousand-year older temple at its side; it is simply a "magnificent archaïsm."

When it was built the older and smaller temple was still used as a temple, apparently, and both existed side by side for some time; this is shown by the fact that the later temple is not placed in the centre of the *cirque*, but is crammed up against the northern cliff-face; it could not be placed in the exact centre because the southern portion of the space at Deir el-Bahari was already occupied by the older temple. It was built roughly parallel to the older temple; it is oriented 24° S. of E. (Lockyer, "Dawn of Astronomy," p. 212), and this must be more or less the orientation of Nebkherurā's temple also. This fact is of interest, as the question might be mooted whether the orientation of the main temple is also an archaïsm, imitated from that of Nebkherurā's temple (B.C. 2500), or not. Sir Norman Lockyer has already postulated ("Dawn of Astronomy," p. 218) the existence in the western hills of Thebes of a temple of Hathor older than the shrine of the goddess at Deir el-Bahari, "built to observe the rising of the star [Hathor-Sothis, *i.e.* Sirius] at a time perhaps somewhat later than that given by Biot (3285 B.C.)." Nebkherurā's date is about 2500 B.C., but we have as yet no proof that in his funerary temple the reverence paid to his spirit was conjoined with a worship of Hathor. We may find this proof in the course of the further excavations, or the older temple of Hathor may have existed further to the southward, perhaps on the site of the present little temple dedicated to Hathor of the Waste at Deir el-Medina, which was originally founded in the reign of Amenhetep III., B.C. 1450. Certain it is that the worship of Hathor in the western hills is far older than the time of Amenhetep III. and Hatshepset, and the foundation of the oldest temple built in her honour at Deir el-Bahari or Deir el-Medîna may well go back to very near the date propounded by Biot for the first systematic observation of the heliacal risings of Sothis-Hathor (Sirius). It is to this very period—between 3285 B.C. and 2400 B.C.—that the beginnings of the Theban Empire and of the Theban temples must be placed. To the student of the astronomical orientation of Egyptian temples the new discovery will, therefore, be of the highest interest.

Among the large number of smaller objects discovered in the course of the excavations, the most interesting will probably prove to be the series of small *ex-votos* of devotees of Hathor, found in the court between the two temples. These consist of small cows (the sacred animal of the goddess), and female figures in earthenware and blue faïence, votive eyes and ears

in bronze and faïence, broken blue vases with representations of the holy cow emblazoned with stars, &c. These votive offerings, which nearly all date to the eighteenth dynasty, were undoubtedly originally devoted in the Hathor shrine of the great temple, and when the shrine became too full were thrown down by the sacristans into the space between the two temples, which thus became a dust-heap. And from this dust-heap many interesting objects have been recovered, including a copper chisel with hardened edge, which should be of special interest to metallurgists, and specimens of palm-fruit, nuts, reeds, and shells, dating to about 1500 B.C. One of the most remarkable objects found is a perfect three-cornered loaf of unleavened bread, of the same date. All these smaller objects, together with a number of specimens of the eleventh dynasty reliefs already described, will, we understand, be exhibited at the annual exhibition of the Egypt Exploration Fund at University College, Gower Street, in July next.

Subscriptions for the work of the Egypt Exploration Fund are much needed, and should be sent to the Secretary, 37 Great Russell Street, W.C. We are indebted to Mr. Hall for the photographs here published.

NOTES.

THE achievements of the Japanese in the war are causing increased attention to be given to the influence of brain-power on history. National enlightenment, and the scientific spirit which welcomes every increase of knowledge, are the two chief factors of progress in these days, and the Japanese successes have shown the power of both these attributes. An important article in the *Neue Freie Presse* of Vienna lays emphasis upon the use which Japan has made of its brain-power; and the following extract from a summary published in Monday's *Times* shows how the prediction made by Sir Norman Lockyer in his address to the British Association last year is being fulfilled:—" Japan has adopted modern civilisation with soul and body. She has not merely copied those externals of modernity which rob an uncivilised people of originality without giving any real value in exchange, but she has assimilated eagerly the ideas of modern culture. Modern are her schools, in which the children of all creeds are taught morals, but not religion, in order to avoid all ecclesiastical intolerance. Modern is her view that priests should refrain from political struggles, and should reserve themselves for the leading place in pious exercises. Modern is her wish, despite many a hard rub during the time of transition, to respect without prejudice all free-minded criticism of public affairs and not to crush opposition by brute force, or, worse still, to intimidate it by a system of crafty calumny. Modern also are her sincere respect for freedom of research, her joy in a conception of the universe which makes intelligence, not superstition, the regulating power of human acts, and greets with gladness every new discovery and every new thought; and modern is a policy which incites minds to development instead of fettering them, which favours instead of suppressing the sheer delight in material production."

A CONVERSAZIONE of the Institution of Electrical Engineers will be held at the Natural History Museum on the evening of Tuesday June 28.

THE death is announced of Dr. Max Kaech, officer in charge of the geological collections of the national museum of natural history and ethnography—the Museu Goeldi—at Para, Brazil.

A MEETING of members of council of the South African Association for the Advancement of Science was held at Johannesburg on May 19, Mr. T. Reunert presiding. The chairman reported that he had been in communication with the German, French, Austrian, and Italian Consuls, and was hopeful of the cooperation of these gentlemen in connection with the visit of Continental delegates to South Africa with the British Association next year. Dr. Pakes, referring to the impending departure of Mr. Reunert for England, mentioned that he would represent the South African Association at the forthcoming Cambridge meeting of the British Association.

THE Antarctic ships *Discovery* and *Morning* have sailed from Lyttelton for Plymouth.

THE Institution of Electrical Engineers visited Colchester on Saturday on the occasion of the formal reception and unveiling of an historical picture presented by the institution to the town of Colchester in commemoration of the tercentenary of Dr. William Gilbert, the "father of electrical science," who was born in Colchester.

IN connection with the St. Louis Exposition, an International Electrical Congress has been arranged from September 12 to 17. It will be divided into eight sections, for which the following have been appointed chairmen and secretaries respectively:—A, general theory, Prof. E. L. Nichols, Prof. H. T. Barnes; B, general applications, Prof. C. P. Steinmetz, Prof. Samuel Sheldon; C, electrochemistry, Prof. H. S. Carhart, Mr. Carl Hering; D, electric power transmission, Mr. C. P. Scott, Dr. Louis Bell; E, electric light and distribution, Mr. J. W. Lieb, jun., Mr. Gano S. Dunn; F, electric transportation, Dr. Louis Duncan, Mr. A. H. Armstrong; G, electric communication, Mr. F. W. Jones, Mr. B. Gherardi; H, electrotherapeutics, Dr. W. J. Morton, Mr. W. J. Jenks. It is at present intended to limit the number of papers to 150, and the transactions are expected to fill three octavo volumes. Mr. Elihu Thomson is president, and Dr. A. E. Kennelly, of Harvard University, general secretary of the congress.

THE annual general meeting of the Ray Society was held on June 9, Lord Avebury, president, being in the chair. The report announced the attainment of the society's sixtieth year; the death of two vice-presidents, Dr. C. H. Gatty, F.R.S., and Mr. R. McLachlan, F.R.S.; the completion of Newstead's "British Coccidæ" and of Michael's "British Tyroglyphidæ." The volumes to be issued during this year and next were stated to be:—Vol. i. of the "British Desmidiaceæ," by Mr. W. West and Prof. G. S. West; vol. i. of the "British Tunicata," by the late Joshua Alder and the late Albany Hancock; vol. i. of the "British Freshwater Rhizopoda and Heliozoa," by James Cash; and vol. ii. of the "Desmidiaceæ." The officers and council elected for the ensuing year were:—President, Lord Avebury, F.R.S.; vice-presidents, Dr. R. Braithwaite, Mr. A. D. Michael, and Lord Walsingham, F.R.S.; treasurer, Dr. DuCane Godman, F.R.S.; and secretary, Mr. John Hopkinson.

THE use that is being made of wireless telegraphy in connection with the war is shown by the following extract from a private letter received from the *Times'* operator at Wei-hai-wei, and published in Wednesday's issue:—" All the British warships, from the third-class cruisers up, are equipped with Marconi, about twenty-four in all; nearly all the Japs have wireless equipment; the Russian ships are equipped, and several German vessels. One or another of them can be heard any time, day or night. The Japs are

particularly numerous, and we are at it all the time. We laugh at them, for we have struck some good points in tuning, which settle them very nicely. On the boat, when receiving our stuff, two of the four wires are grounded directly, which gives best results. Any resistance between those wires and the ground weakens the signals. If we want to hear the Japs call, disconnecting ground wire entirely from syntoniser of the receiver brings them in strong; while with the ground wire on, as in receiving our stuff, the Japs come very faintly. On the shore station it is different. Three wires are best in receiving up to 100 miles, with the other two wires free, at which time the Japs come in weakest. By grounding the other two wires the Japs come in very strong and our stuff weakest. Above 100 miles our stuff comes best with two wires grounded directly. That, of course, allows others to come in, but they are not strong enough to prevent my reading through. So far, that tuning is best, and certainly gives very satisfactory results."

A REUTER message from New York states that Mr. Marconi's effort to supply news daily on board the Cunard liner *Campania* has been entirely successful. The daily news bulletin was issued to the passengers at breakfast. The *Campania* had not long started when news was received from the Seaforth station, and later in the evening from Poldhu. Touch was kept with the latter station until a distance of 2300 miles had been reached on June 9. At 2 a.m. on that date communication was established with Cape Breton, 2000 miles distant, and was maintained until the end of the trip. On June 8 Cape Cod station, 1030 miles distant, was picked up, Cape Breton and Poldhu being also in communication with the ship. On the following day news bulletins were received from the American stations. Communication was begun with Nantucket at 3 p.m. on June 10, news being received from that place as well as from Cape Breton and Cape Cod. In addition to the shore stations, communication was established with the *Etruria* and the *Aurania*. The *Lucania* exchanged news with the *Campania*, and a number of private messages were sent at intervals. Touch with both sides of the Atlantic was continuous for three days in mid-ocean.

WE learn from the *Pioneer Mail* that, through the initiative of Mr. E. H. Aitken, a zoological society is about to be founded in Sind with the object of promoting the study of animal life. The society will not aim at making collections of its own, but rather at improving those already existing in the municipal gardens and museum, and turning them to the best account for scientific purposes.

AT the suggestion of Prof. W. F. Barrett, Royal College of Science, Dublin, Mr. P. E. Belas described in NATURE of May 12 (p. 31) a simple method of showing vortex motion by allowing aqueous fluorescein to flow from a capillary tube with its point just below the surface of water in a tall cylinder, and then tapping the stand supporting the tube. Mr. Robert E. Doran, of Queen's College, Cork, writes to direct our attention to the fact that he has performed a similar experiment in his demonstrations for the past six or seven years. Mr. Doran recommends that a bulb be blown at one end of a glass tube, and that the open end be contracted to slightly less than 1 mm. bore. The bulb and tube are filled completely with a 1 per cent. solution of common salt to which fluorescein has been added to produce a liquid almost free from fluorescence. The tube is clamped vertically over the centre of a tall cylinder filled with water. When the water is at rest the tube is lowered until its aperture just touches the surface. This starts the experiment, and no tapping is necessary. Several photographs showing the vortex rings resulting from his method of procedure accompany Mr. Doran's letter.

IN *La Nature* of May 28, Dr. A. Hamberg, of Stockholm, gives an interesting account of his successful establishment of meteorographs on two mountains in Swedish Lapland. One set of apparatus, that shown in the accompanying illustration, is on the Portitjokko, at an altitude of 1850 metres, and has been working satisfactorily since July, 1902, with the exception of occasional interruptions of the anemometer owing to hoar-frost. The second apparatus is installed on the Sähkok, at an altitude of about 1080 metres. The barograph and thermograph were constructed by M. Richard, of Paris; the other instruments were made by Dr. Hamberg, with the aid of M. Linderoth, clockmaker, in Sweden. Each set of apparatus weighs 1000 kilograms, and the separate parts had to be conveyed by men and reindeer. The clocks go for a year, each "weight" being 300 kilograms. The recording portions of the meteorograph are encased in screens of sheet iron, inside which pans of calcium chloride are placed. The apparatus on the left of the diagram is the pluviograph. Instead of using ink,

which was found to be unsatisfactory, punctures are made every twenty minutes in the papers covering the drums of the instruments, and occasionally in the autumn the deposit of hoar-frost has to be cleared away by Laplanders. The great difficulties of the problem have only been overcome by Dr. Hamberg after persistent and tedious experiments, both as to position and methods of registration.

WE have received from the secretary of the Meteorological Office an excerpt paper containing some of the principal meteorological subjects dealt with in Section A of the British Association meeting at Southport. Among these is a paper on the general circulation of the atmosphere, by Dr. H. H. Hildebrandsson, being a summary of a report to the International Meteorological Committee (Upsala, 1903), which will attract attention. The author points out that while, thanks to the labours of Maury, Brault and others, the system of winds prevailing at the surface of the earth is well known, our knowledge of the motions of the upper currents gained from general publications is mostly based upon theoretical considerations. The late Rev. W. C. Ley commenced observations on the upper clouds in 1872, and in the following year the author established a series of cloud observations in Sweden with the object of determining the movements of the air at different altitudes in areas of high and low barometric pressures. These observations have been supplemented during recent years by experiments with balloons and kites. The result of these investigations, the author states, will render it necessary to abandon once for all the theory hitherto adopted of a

vertical circulation of the atmosphere between the tropics and the poles, and he expresses the hope that the terms "polar" and "equatorial" currents, which have hitherto caused so much confusion in dynamical meteorology, will disappear completely from meteorological science. In his important paper he shows, for instance, that in all parts of the temperate zone of the northern hemisphere an upper current from west to east prevails in all months of the year, while in the tropical zone the currents at all heights are almost without exception from east to west. Another important contribution, by M. L. Teisserenc de Bort, on barometric depressions at various altitudes, is contained in the excerpt above referred to, which corroborates the conclusions arrived at by Dr. Hildebrandsson.

THREE papers on terrestrial magnetism from the reports of the U.S. Coast and Geodetic Survey for 1902 and 1903 have just been received. In a paper on "Magnetic Observatories of the United States Coast and Geodetic Survey," Dr. L. A. Bauer and Mr. J. A. Fleming describe very fully the various points which have to be considered in determining suitable sites for magnetic observatories, and the question whether the elimination of magnetic material in the construction of observatories is essential when used only for observations of variations and not absolute values is discussed. A description of three observatories is given, and the paper is illustrated with maps of the selected sites and with views of the observatories and of the instruments used. A paper on "Magnetic Dip and Intensity Observations (January, 1897, to June 30, 1902)," by Mr. D. L. Hazard, gives full details of the magnetic elements determined at 800 stations—about one-fifth of the total number proposed for the general magnetic survey. In addition to the field observations, the variations of declination and of the horizontal intensity are recorded photographically at four observatories, at each of which the absolute values of the elements are determined at least once a week. Much difficulty was found in obtaining concordant results with different dip circles; subsequently an earth-inductor was selected as a standard dip instrument. In the third paper —"Results of Magnetic Observations made by the Coast and Geodetic Survey between July, 1902, and June, 1903" —Dr. L. A. Bauer describes the method of taking field observations, and gives tables of the results and a full description of each station used for the observations. It is evident that every precaution is taken that each station may be accurately located at any future date.

AMONG our weekly budget of pamphlets, we may refer to a copy of the *Proceedings* of the South London Entomological and Natural History Society for 1903, and also to one of the *Proceedings* of the Philadelphia Academy for April. The latter contains an important paper, by Dr. D. B. Castell, on the cell-lineage and larval development of the nudibranch mollusc *Fiona marina*.

MR. W. E. CLARKE has favoured us with a copy of a paper from the *Proceedings* of the Royal Physical Society of Edinburgh (vol. xv., part ii.) in which he describes, under the name of *Mus musculus faeroensis*, a new form of house-mouse from the Færöes. Large size and certain peculiarities in colour are the distinctive features of this race.

THE medusas of the Bahamas form the subject of the first issue of a new serial (vol. i., No. 1)—the *Memoirs of Natural Sciences*—published by the Brooklyn Institute. Compared with that of the Tortuga Islands, off Florida, the medusa-fauna of the Bahamas has been found by the author—Mr. A. G. Mayer—to be comparatively poor. This is accounted for by the circumstance that the Tortugas stand in "blue water," whereas the Bahamas are surrounded with shallow flats of coral-mud, very sterile in animal life generally.

AN important discovery with regard to the breeding of the cod is recorded by Mr. T. W. Fulton in the *Publications* (No. 8) of the International Council for the Exploration of the Sea. As a rule, cod spawn from January to June—chiefly in March—but some of these fish recently taken on a patch of rocky ground in the North Sea lying to the north-east of Aberdeen, off the coast of Norway, were found to be spawning in September and October. It was already known that the herring has a spring and an autumn spawning season, and now we have proof that, in one area at any rate, the same holds good for the cod. An interesting point for determination is whether there is any difference between the spring and the autumn fry.

DR. C. W. ANDREWS, of the British Museum, has recently returned from Cairo, where he had been studying the fine series of vertebrate remains from the Fayum district. A number of specimens have, we understand, been acquired by exchange for the British Museum, while the series in the museum of the Egyptian Geological Survey at Cairo has been arranged and developed by Mr. Barlow, jun., of the formatori's staff at the Natural History Museum, who went out some months ago for that purpose. Among the more important specimens at Cairo is a young skull of *Arsinoitherium zitteli*, exhibiting the cranial sutures, and thus permitting the identification of the bones from which the huge front horns arise.

FOR nearly twenty years Mr. F. M. Webster, of the Illinois Natural History Laboratory, has been endeavouring to find a means of mitigating the plague of "buffalo-gnats" (*Simulium invenustum*), which of late years have proved so disastrous to cattle-owners in the districts bordering the lower course of the Mississippi. The remedy is a simple, although somewhat expensive one, namely, to prevent the great river from overflowing its banks, for it is in such overflows that these noxious little flies breed, and thus overrun the country. That their ravages are no trifling matter may be gathered from the statement that in 1882 a farmer in Louisiana lost 3200 head of stock from their attacks. Wild animals are terribly tormented by these pests, and a white-tailed deer has actually been known to rush into a blacksmith's forge to obtain relief in the smoke from their bites.

A PAPER on "Fertility in Sheep," by Mr. F. H. A. Marshall (*Trans.* Highland and Agric. Soc., Scotland), directs the attention of stock breeders to certain points of practical interest which are discussed in a recent memoir by the author on the œstrous cycle in the sheep, published in the *Philosophical Transactions*, and noticed in NATURE of September 3, 1903 (vol. lxviii. p. 429). The paper concludes with suggestions for future investigations on fertility in the ewe.

MR. THOMAS BURLEIGH has published a second edition of Mr. E. F. Chidell's "Africa and National Regeneration" (pp. 78). The preface to the new issue occupies more than half the pages of the book.

THE list of spectroscopes and spectroscopic accessories just issued by Messrs. Adam Hilger, Ltd., is conveniently arranged, and supplies useful information concerning a great variety of instruments for general work and for special purposes. Among other interesting apparatus described we notice film replicas of Rowland's diffraction gratings with 14,438 lines per inch, and the Michelson echelon diffraction gratings with the number of plates ranging from ten to forty.

A SECOND revised edition of "An Elementary Geography of India, Burma, and Ceylon," by Mr. Henry F. Blanford, F.R.S., has been published by Messrs. Macmillan and Co., Ltd. The important changes which have been made in Indian geography since the appearance of the first edition of the book have caused the author to re-write several portions, and to add new chapters on the North-west Frontier Province and on the Laccadive and Maldive Islands.

WE have received from the Wentworth Publishing Co., of Surrey Street, W.C., a copy of their new "Seaside and Inland A.B.C. Holiday Guide." The book runs to 311 pages, and contains concise descriptions of all health and pleasure resorts and places of interest in the United Kingdom. Lists of all the golf links throughout the kingdom, of all British spas, of the principal angling stations, and of the coaching centres are also provided. This useful guide costs one shilling net.

ACCORDING to a communication of J. Knett which appears in the *Sitzungsberichte* (No. 11) of the Vienna Academy of Sciences, the thermal springs of Karlsbad deposit small yellow tabular crystals of barium sulphate which are distinctly radio-active, and show all the phenomena characteristic of the presence of an active element.

THE May number of the *Physical Review* contains interesting papers on "Potential Phenomena in Vacuum Tubes during the Production and Interruption of Electrical Discharge," by S. N. Taylor, and "Observations on the Radiation produced in an Alternating Condenser Field," by F. Sanford.

THE investigation of certain complex cerium compounds by Prof. B. Brauner, an account of which appears in the current volume, No. 39, p. 261, of the *Zeitschrift fur anorganische Chemie*, throws considerable light on the nature of certain cerium compounds which have been the subject of discussion for several decades. The red coloured salt which separates from the solution obtained by the action of water and sulphuric acid on oxide of cerium is shown to be the acid cerous salt of the complex cerisulphuric acid, and is represented by the formula

$$Ce^{iv}(SO_4)_4Ce^{iii}H.12H_2O.$$

Perfectly similar compounds, in which the trivalent cerium is replaced by lanthanum, neodymium and praseodymium, have also been obtained.

SOME interesting facts relating to the influence of the application of potash salts on the agricultural production of Prussia are contained in a recent address by Dr. Carl Ochsenius to the Philadelphia Academy of Sciences. In 1893 the consumption of potash in German agriculture was 60,000 tons, in 1903 it was 150,000 tons. The following numbers give the yields per hectare in kilograms of different kinds of produce for the two years in question:—

	Summer wheat	Summer rye	Summer barley	Oats	Clover and Lucerne	Hay
1893	1477	872	1517	1067	2249	2275
1903	2304	1023	1988	1837	5250	4056

THE existence of a urea-forming enzyme has recently been demonstrated by Kossel and Dakin (*Zeit. physiol. Chem.*, xli., 321, &c.). The enzyme occurs principally in the liver, but is also present in the thymus gland, mucous membrane of small intestine, kidney and lymphatic glands. It possesses the property of causing the rapid decomposition of arginine (δ-guanido-α-amidovaleric acid), which is one of the end products of tryptic digestion, into ornithine (αδ-diamidovaleric acid) and urea. The enzyme may be roughly isolated by precipitation of extracts of liver with alcohol and ether, or with ammonium sulphate, and may be preserved in the solid form for many months with but little change. The conversion of arginine into urea and ornithine illustrates a new type of enzyme reaction. The enzyme has been named "arginase," and is the first representative of the class of urea-forming enzymes capable of being isolated and of acting outside the body.

OUR ASTRONOMICAL COLUMN.

COMET 1904 *a*.—A new set of elements and an ephemeris for this comet are published in No. 3947 of the *Astronomische Nachrichten* by Prof. Strömgren. These vary but slightly from those previously published by Herr Ebert. Observations made on May 19 gave corrections of $-41s.$ in R.A. and $+2'.2$ in declination to the positions, for that date, derived from Prof. Strömgren's elements, thereby showing the latter to be fairly correct. From this fact it follows that the object which appeared on the Harvard photographs of March 11 and 15, which was thought to be this comet, must have been some other body, for its position is about 6° from the comet's position on that date as deduced from these elements.

The comet's orbit is probably parabolic, and is noteworthy for its large perihelion distance, somewhat similar to that of Giacobini's comet of 1902–3 (the *Observatory*, No. 345).

DURATION OF THE PERSEID SHOWER.—In a letter to the *Observatory* (June), Mr. Denning directs attention to the long duration of the annual shower of Perseids. He states that the shower is certainly active by July 19, and that it has not entirely ceased on August 16; there is some evidence that traces of it have been observed as early as July 7 and as late as August 25, a period of fifty nights.

Mr. Denning also gives a list of radiants for various stages of the shower, derived from the collected observations made during the period 1877–1903 inclusive.

Moonlight will not interfere with the observation of either the earlier stages (July 8–19) or the maximum and latest phases (August 6–19) of this year's shower.

FOUNDATION OF A NEW ASTROPHYSICAL OBSERVATORY.—A letter from Dr. C. Nordmann to the *Revue générale des Sciences* (No. 10, May 30) describes the aims and equipment of a new astrophysical observatory which has just been built near to Tortosa, in Spain, in latitude 40° 48′ N. and longitude 1° 47′ E. of Paris.

The general idea of the work to be prosecuted is to obtain information regarding the relations between solar and terrestrial phenomena, relations the existence of which has of late years been abundantly confirmed by all workers in solar physics.

Two magnetic houses have been equipped, the one for absolute measures of terrestrial magnetism, the other for obtaining records of the regular variations in the elements and of the extraordinary disturbances which appear to coincide, in point of time, with solar disturbances.

The observatory is also to be furnished with an equatorial for observing sun-spots, an Evershed photo-spectroheliograph, and an instrument for determining the radial velocities of solar prominence eruptions.

Another building has been set apart for meteorological observations and the study of atmospheric optics, and seismological observations have also been provided for.

THE TOTAL SOLAR ECLIPSE OF 1905.—In an article published in the *Popular Science Monthly* for June, Prof. W. W. Campbell gives an interesting *résumé* of what has already been achieved by eclipse expeditions, and indicates the present state of our knowledge regarding eclipse phenomena. He then suggests a number of observations which might be profitably made during the eclipse of May, 1905. Amongst these he considers the search for an intra-mercurial planet to be of prime importance. The observations of Perrine in 1900 seemed to negative the idea of such a planet's existence, but no *definite* conclusions could be formed owing to the intermittently cloudy state of the

sky at the time when the photographs were taken. Prof. Campbell suggests that cameras similar to those used by Perrine should be used in Labrador, Spain, Tunis, and Egypt. He also insists upon the necessity for setting up coronagraphs at each of these widely separated stations in order to determine whether or not any real changes take place in the corona during the eclipse.

The determination of the correct wave-length of the chief corona line is also suggested as being of great importance. Finally, he urges upon observers the vital importance of thoroughly testing all their instruments before leaving home, and of allowing themselves plenty of time to make the final adjustments whilst in the eclipse camp.

ACTUAL DISTANCES BETWEEN STARS.—By simple trigonometrical calculations, Mr. J. E. Gore has deduced some interesting facts regarding the probable actual distances between certain stars the parallaxes of which are known with some degree of certainty. Thus he has determined that Sirius and Procyon are separated by about half the distance between the former star and our own system, therefore Sirius as seen from Procyon would appear as a star of magnitude $-3{\cdot}08$. In the case of η and μ Cassiopeiæ, the actual distance between them is probably about one-fifteenth their distance from the sun, and their apparent brilliancies would therefore be about 225 times as great as they appear to us. In the case of double stars, these figures become much greater; for example, if we take 61 Cygni, the distance separating the components is about 55 astronomical units, and, as they are probably situated at some 515,662 astronomical units from the earth, their apparent brightness would be increased about 88 million times, or by 19·8 magnitudes, if seen at the distance which separates them. Similarly, the brightness of each of the components of α Centauri would be increased by 19·7 magnitudes (the *Observatory*, No. 345).

THE SUCCESSION OF CHANGES IN RADIO-ACTIVE BODIES.[1]

IT has been shown by Rutherford and Soddy that the radio-activity of the radio-elements is always accompanied by the production of a series of new substances possessing some distinctive physical and chemical properties. These new substances are not produced simultaneously, but arise in consequence of a succession of changes originating in the radio-elements. The radio-activity of these products is not permanent, but diminishes in most cases, according to an exponential law with the time. Each product has a distinctive rate of decay of activity, which has not, so far, been altered by any physical or chemical agency. The law of decay has been explained on the supposition that the product undergoes change according to the same law as a mono-molecular change in chemistry. The change occurs in consequence of the expulsion of an α or β particle, or both, and the activity of a product is thus a measure of its rate of change. While the products, like the emanations, and UrX, lose their activity according to an exponential law, the matter emanation X, which gives rise to the phenomena of excited activity, does not lose its activity according to a simple law. The experiments of Miss Brooks and the author, and of Curie and Danne, have shown that the decay of the excited activity of radium is very complicated, and depends upon the time of exposure to the exciting cause, viz. the emanation. The author has shown that the excited activity produced in a body by a short exposure in the presence of the thorium emanation increases at first for a few hours, passes through a maximum value, and then decays with the time according to an exponential law.

In the paper the curves of decay of excited activity of radium and thorium are given for both short and long exposures to the emanations, and it is shown that the law of change of activity with time can be completely explained on the theory that emanation X of thorium and radium is complex, and undergoes a series of successive changes.

The mathematical theory of successive changes is given in detail, and a comparison is made of the theoretical and experimental curves obtained for the variation with time of the excited activity. In the case of thorium, two changes are found to occur in emanation X. The first change is a "rayless" one, *i.e.* the transformation is not accompanied by the appearance of α, β, or γ rays. The second change gives rise to all three kinds of rays.

The decay of activity of emanation X of radium depends greatly on whether the α or β rays are used as a means of measurements. The curves obtained by the β rays are always identical with those obtained by the γ rays, showing that the β and γ rays always occur together and in the same proportion. The complicated decay curves obtained for the different types of rays, and for different times of exposure, can be completely explained on the supposition that there are three rapid successive changes in the matter deposited by the emanation, viz. :—

(1) A rapid change, giving rise only to α rays, in which half the matter is transformed in about three minutes.

(2) A "rayless" change, in which half the matter is transformed in twenty-one minutes.

(3) A change giving rise to α, β and γ rays together, in which half the matter is transformed in twenty-eight minutes.[1]

A similar rayless change is shown to occur in the "emanating substance" of Giesel.

The occurrence of a rayless change in the three radio-active bodies is of considerable interest. Since the change is not accompanied by rays, it can only be detected by its effect in the change or changes which follow. The matter of the rayless change is transformed according to the same law as the other changes. The rayless change may be supposed to consist either of a rearrangement of the components of the atom or a disintegration of the atom, in which the products of the disintegration are not set in sufficiently rapid motion to ionise the gas or to affect a photographic plate. The significance of the rayless changes is discussed, and the possibility is pointed out that similar rayless changes may occur in ordinary matter; for the changes taking place in the radio-active bodies would probably not have been detected if a part of the atom had not been expelled with great velocity.

The radiations from the different active products have been examined, and it is shown that the β and γ rays appear only in the last rapid change of each of the radio-elements. The other changes are accompanied by the emission of α particles alone.

Evidence is given that the last rapid change in uranium, radium, and thorium, which gives rise to β and γ rays, is far more violent and explosive in character than the preceding changes. There is some evidence for supposing that, in addition to the expelled α and β particles, more than one substance is produced as a result of the disintegration.

After the three rapid changes have taken place in emanation X of radium, there remains another product, which loses its activity extremely slowly. Madame Curie showed that a body, which had been exposed for some time in the presence of the radium emanation, always manifested a residual activity which did not appreciably diminish in the course of six months. A similar result has been obtained by Giesel. Some experiments are described, in which the matter of slow decay, deposited on the walls of a glass tube containing the emanation, was dissolved in acid. The active matter was found to emit both α and β rays, and the latter were present in unusually large proportion. The activity measured by the β rays diminished in the course of three months, while the activity measured by the α rays was unaltered. The active matter was complex, for a part which gave out only α rays was removed by placing a bismuth plate in the solution. The radio-active matter deposited on the bismuth is closely allied in chemical and radio-active properties to the active constituent contained in the radio-tellurium of Marckwald. The evidence, as a whole, is strongly in support of the view that the active substance present in radio-tellurium is a disintegration product of the radium atom. Since the radium emanation is

[1] Bakerian Lecture delivered at the Royal Society on May 19 by Prof. E. Rutherford, F.R.S.

[1] A statement of the nature of the three changes occurring in emanation X of radium was first given in a paper by Rutherford and Barne (*Phil. Mag.*, February). A brief account of the theory from which th results were deduced has been given in my book "Radio-activity" (Cambridge University Press). Later, Curie and Danne (*Comptes rendus*, March 14) arrived, in a similar way, at the same conclusions.

known to exist in the atmosphere, the active matter of slow dissipation produced from the emanation must be deposited on the surface of all bodies exposed to the open air. The radio-activity observed in ordinary materials is thus probably, in part, due to a thin surface film of radio-active matter deposited from the atmosphere.

A review is given of methods of calculation of the magnitude of the changes occurring in the radio-elements. It is shown that the amount of energy liberated in each radio-active change, which is accompanied by the emission of α particles, is about 100,000 times as great as the energy liberated by the union of hydrogen and oxygen to form an equal weight of water. This energy is, for the most part, carried off in the form of kinetic energy by the α particles.

A description is given of some experiments to see if the α rays carried a positive charge of electricity, with the view of determining experimentally the number of α particles projected from one gram of radium per second. Not the slightest evidence was obtained that the α rays carried a charge at all, although it should readily have been detected. Since there is no doubt that the α rays are deflected in magnetic and electric fields as if they carried a positive charge, it seems probable that the α particles must in some way gain a positive charge after their expulsion from the atom.

Since, on the disintegration theory, the average life of a given quantity of radium cannot be more than a few thousand years, it is necessary to suppose that radium is being continuously produced in the earth. The simplest hypothesis to make is that radium is a disintegration product of the slowly changing elements uranium, thorium, or actinium present in pitchblende. It was arranged that Mr. Soddy should examine whether radium is produced from uranium, but the results so far obtained have been negative.

I have taken solutions of thorium nitrate and the "emanating substance" of Giesel (probably identical with the actinium of Debierne) freed from radium by chemical treatment, and placed them in closed vessels. The amount of radium present is experimentally determined by drawing off the emanation at regular intervals into an electroscope. A sufficient interval of time has not yet elapsed to settle with certainty whether radium is being produced or not, but the indications so far obtained are of a promising character.

RECENT PUBLICATIONS IN AGRICULTURAL SCIENCE.[1]

THE United States Department of Agriculture has issued the fourth annual instalment of the great work upon which its Division of Soils has embarked, the detailed survey of the soils of the whole of the country. The area covered by the present report is little less than 18,000 square miles, which have been surveyed at a total cost of 12*s.* per square mile. The work is being carried on simultaneously in many parts of the States; the counties dealt with embrace some of the old settled eastern States like New York and New Jersey, the Carolinas and Virginia, the rich lands of Ohio, Kentucky and Illinois, also the recently settled districts in the Dakotas, Texas, Colorado and other areas of deficient rainfall, the Walla Walla wheat area on the Pacific slope, and the lately acquired dependency of Porto Rico.

The method adopted follows that of the earlier reports; a field party maps the distribution of the soils in each section and collects information as to the crops grown and their average yields, the conditions of labour and transportation, at the same time indicating the suitability of the land for new crops and systems of farming. Mechanical analyses of each type of soil are made at Washington and are set out in the report; occasionally chemical analyses are included; statistics of rainfall and mean temperature are also added.

The whole work is based upon the facts that different types of soil can be recognised and the areas which they occupy can be approximately mapped, and that particular crops and systems of farming can be associated with the various soil types, so that the agriculture of each area can be directed along the most appropriate lines and its farmers saved from many unprofitable experiments. While the volume contains no striking novelty, it is full of interest and instruction to the English student of agriculture or economics.

M. Tribordeau gives an account of the agricultural condition of the Pas-de-Calais, dividing it into regions based upon geological considerations of the nature of the subsoil. A description of each soil is given, generally accompanied by several analyses by M. Pagnoul; then follows an account of the agriculture, with reports in considerable detail of the system pursued on one or more farms of different sizes in the area. The varieties of each crop generally grown, the races of live stock, the yield, the conditions of labour, even the implements in use on each farm are carefully set out. The latter half of the volume deals more generally with the agricultural economics of the district, and discusses the position both financial and moral of the labouring class, the conditions of tenure, the societies and other means adopted for the encouragement of agriculture, particularly the spread of the movement for credit banks and cooperative associations. The work is liberally illustrated with maps, photographs and diagrams, and presents a valuable picture of the present critical condition of agriculture in western Europe.

The current volume of the *Journal* of the Royal Agricultural Society, which now appears annually only, is somewhat more exclusively occupied than usual with the work of the society. In addition to the usual prize lists there is a general account of the show held at Park Royal last June, another article on the machinery exhibited there, and a full discussion of the trials of wind pumping engines conducted by the society in 1903. Reports of committees and of the scientific officers of the society also bulk largely, including Dr. J. A. Voelcker's account of the experiments in progress on the farm at Woburn and at the Hills pot-culture station. Turning to the general articles, the interest that is being manifested in forestry is seen in the two opening papers; in one Mr. C. E. Curties treats generally of the management of British woodlands, and in the other Mr. R. Anderson deals with the utilisation of home grown timber and its bye products. Mr. Spencer Pickering describes his experiments at the Duke of Bedford's fruit farm at Woburn, which he has repeated on a different soil at Harpenden, on the ill effects produced by growing grass round apple trees.

The volume is completed by one or two statistical papers and an article by Mr. A. D. Hall on the manuring of grass land, in which he takes the Rothamsted experiments upon grass land as his starting point, and then proceeds to discuss the many other manurial experiments upon hay or pasture which are now in progress in various parts of the country.

[1] "Field Operations of the Division of Soils, 1902." By Milton Whitney. Pp. 842; with a case of maps. (Washington: U.S. Department of Agriculture, 1903.)

"Monographie Agricole du Pas-de-Calais." By M. Tribordeau. Pp. 296. (Paris: Société d'Encouragement pour l'Industrie Nationale, 1904.)

"The Journal of the Royal Agricultural Society of England," vol. lxiv. Pp. 420+clxxxviii. (London: John Murray, 1903.)

MAIDSTONE MEETING OF THE SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES.

THE ninth annual congress of the South-eastern Union of Scientific Societies opened on the evening of June 9, when Sir Henry Howorth, the outgoing president, resigned his seat to Mr. Henry Rudler, who delivered the annual address at the Town Hall, Maidstone.

Mr. Rudler alluded to his address as a string of commonplaces, but in it some very important topics were touched upon. He considered, for instance, the constitution of scientific societies, and the matters to be discussed at their meetings in these days of great specialisation. He divided the members of such societies as constitute the union into those (few in number) who do the work and those (the majority) who like to see what is being done. Mr. Rudler was of opinion that the latter should have their wants realised as well as the specialists, for to put it on the lowest plane, the societies generally depended upon the financial support of those intellectual people who take a general interest in the progress of science without aiding in it themselves. Mr. Rudler's advice was to hold sectional meetings for the specialists, where the matters to be considered might be as technical as occasion required, and to

arrange general meetings where scientific subjects were dealt with in a popular manner. The fact had to be remembered that many of the members came to the meetings after working hard all day, and with their brains more or less exhausted and in need of recreation.

Mr. Rudler also dealt with the craze for athleticism, which tended to lessen the ranks of the local societies and even of the British Association itself. He said that a party on a field excursion would get more physical benefit than a crowd of spectators watching competitions between professional athletes. He contended that the taste for "sport" of to-day was only a part of a large subject, the excessive love of pleasure. He said that different people had different ideas with regard to recreation, but that those who turned to natural history were exceptionally wise in their choice. Parents, and especially ladies, would, he suggested, do well to join a natural history society, if only as an example for the young, and to introduce them to a healthy atmosphere. Now that nature-study was successfully edging its way into our schools, there should be a fine crop of young naturalists in the making, and Mr. Rudler told the societies not to wait for the students to grow up, but to found branches for junior members.

After saying a word as to the secondary place that the results of the camera and the magic lantern should take in popular lectures, Mr. Rudler passed on to speak of the scientific work done by Maidstone men in the past, and to congratulate the town upon its museum.

On the morning of June 10 business was transacted, and officers and committee elected "For the Photographic Record and Survey of Kent," after a report of the work of the provisional committee had been read by Mr. H. Snowden Ward, who had acted as organising secretary.

Mr. F. J. Bennett, in a short paper, pointed out that the Kentish megaliths, like those in Wiltshire, follow lines which run from north to south, and this is also true in the case of earthworks and churches. A paper on the Lepidoptera of mid-Kent, by Captain Saville G. Reid, was taken as read, and the meeting concluded with some excellent suggestions by Mr. Bennett with regard to the utilisation of the twenty-five inch Ordnance maps by farmers. On these a plan of the drainage, the arrangements for which are often completely forgotten, could be entered, together with details of the work carried on from year to year. Mr. Bennett urged that such work should be secured by legislation, and the suggestion met with cordial approval. On the afternoon of June 10 there were two excursions; the first—geological and archæological—was to Aylesford, under the leadership of Mr. Whitaker and Mr. W. H. Benstead. The second was of a botanical and entomological character to the North Downs, under the leadership of Prof. Boulger, Captain Reid, and Mr. Elgar. In the evening the Mayor and Mayoress (Alderman and Mrs. Morling) held a reception in the Museum, Art Gallery and Technical Schools, which adjoin one another in a very convenient way. Afterwards the visitors had an opportunity of examining the Congress Museum, which consisted of specimens sent by members of affiliated societies, and arranged by Mr. E. W. Swanton. There were also on view nature-study exhibits from Kent schools to illustrate the paper to be read on the following morning. During the evening Mr. A. B. Harding read a paper on "Ice Streams and Ice Caves," and Mr. Paul Matthews described the possibilities of an artificial language, and gave an explanation of that which is known as "Esperanto."

On June 11 the election of officers took place. Prof. Flinders Petrie was elected president, and Dr. Abbott, to whom the union owes its origin, exchanged his office of honorary secretary with the Rev. R. Ashington Bullen for that of treasurer, which the latter occupied. The two vacancies on the council were filled with Miss Lawrence, of Reigate, and Mr. Wilfred Mark Webb.

When the last paper, which was on "The Teaching of Nature-study," was read by Mr. Wilfred Mark Webb, a number of teachers and pupil teachers were present through the efforts of the Kent County Education Committee and the local committee of the congress. Considerable discussion took place afterwards. Sir Henry Howorth supported the aim that the pupil should be made to ask why and to find out the answer for himself, and dwelt for some time on the advisability of studying animals in captivity. Prof. Boulger thought that nature-study should, in the case of young children, be correlated with poetry. Mr. Tutt pointed out the difficulties that occur in town schools, and urged the claims of more formal work than had been outlined, which savoured somewhat of science teaching. Mr. J. B. Groom, of St. Paul's Schools, Maidstone, who has made a speciality of rambles, begged the young teachers present to follow informal lines rather than those advocated by Mr. Tutt.

The number of societies now affiliated is forty-three, with upwards of five thousand members, while the funds of the union are in a satisfactory condition, and an invitation has been accepted to visit Reigate during 1905.

EDUCATIONAL CONFERENCE AT THE HORTICULTURAL EXHIBITION.

ON June 7 a conference was held at the Royal Botanic Gardens, Regent's Park, in connection with the educational section of the Horticultural Exhibition, which was open during the whole of last week.

Sir William J. Collins, chairman of the Education Committee of the London County Council, and president of the section, took the chair, and Mr. F. W. Verney read a paper on "Allotment Gardens and Working Men." In the course of this a good deal of stress was laid upon the need for teaching which would prepare country boys to work on the land, and a scheme for their education was mapped out. It seems to be generally recognised that if a boy is ever to do much good on a farm he must become acquainted with its working at an early age, and the compromise desired by Mr. Verney that a boy should be allowed to do some practical work on a farm before his school days are over would not only satisfy practical requirements, but would also probably keep the pupils under the influence of the schoolmaster for a longer period than is at present the case.

Miss Lilian Clark afterwards read a paper upon "Direct Methods of Studying Nature," such as are employed at the James Allen School for Girls, Dulwich. The papers which Miss Clark has read in the past at various science conferences have made us familiar with her work in garden and classroom, where real plants and not books are studied. It is interesting to be able to chronicle that a special room, which is a combination of laboratory and greenhouse, has been built as an aid to the experiments and observations which she directs.

Later in the morning Sir George Kekewich, who is president of the School Nature Study Union, gave an address on "Nature-study and its Cognate Educational Subjects." He made a special point of nature-study as a part of general education, saying that he would like to see it taught in every school in this country. The kind of training outlined was that now generally recognised as being really nature-study, and as Sir George Kekewich is one of those who think that the work, to be done properly, should be carried on out of doors, he spoke of the great difficulties which must exist in the case of most town schools. These difficulties would be all the greater if teachers felt, as Sir George Kekewich seems to do, that to keep animals in captivity (Sir George afterwards excepted canaries) is calculated to teach cruelty.

In the discussion the speakers were practically unanimous in disagreeing with the contention last alluded to. Mr. Hedger Wallace (honorary secretary of the section), Miss Kate Hall, and Miss Von Wyss were among those who thought that many animals could be properly studied "under control." The present writer expressed his opinion that as children see plenty of cruelty in their everyday life, it would be advisable to teach them kindness by keeping pets, and that if this were not done in nature-study, a great power for good would be thrown away.

Sir William Collins summed up nature-study; he said that it was not a new subject, though its recognition and the enthusiasm for it were new, and he emphasised the fact alluded to by Sir George Kekewich that it was not science teaching.

The opinion expressed by Sir George Kekewich that nature-study would not stay the rural exodus, and that its far-reaching effects would not be felt until other means

had been taken to stem the tide of emigration into towns, was not endorsed by the Rev. Claud Hinscliff, who, from his experience in Derbyshire, had come to a different conclusion.

Mr. J. Weathers, instructor in horticulture to the Middlesex County Council, read a paper on "Horticultural Teaching among Adults." His remarks referred mainly to the practical side, though in touching upon laboratory work he said that he believed in practice first and theory afterwards. Mr. Weathers also considered the question of allotments, and in the discussion which followed, Earl Carrington tellingly described from his own experience the advantages derived from small holdings by the tenants, by the landlords, and by the country at large. Mr. J. Martin White thought that a little theory was sometimes good to begin upon, and he pointed out the need for more attention to be paid in general to methods of cutting and keeping flowers for decorative purposes.

Mr. E. Caesar, headmaster of Hale School, Farnham, outlined in a paper "On School Gardens" the scheme of the Surrey County Council, and the work which had resulted in his own school holding premier place for four years running.

The last paper, on "School Nature-study," was by Miss Violet James, of Heidelberg College, Ealing. Miss James has tested the value of nature work, and not only has she discovered its powers for good, but has recognised the opportunities that exist for evil if the teacher pursues wrong lines.

WILFRED MARK WEBB.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In convocation on June 2 the honorary degree of M.A. was conferred on Mr. F. A. Bellamy, first assistant at the university observatory.

Junior Scientific Club:—The ninth Robert Boyle lecture was delivered on June 3 by Prof. J. J. Thomson, F.R.S., on the subject of "The Structure of the Atom." On June 10 Dr. G. Mann, New College, read a paper on "The Importance of Salts in our Economy."

CAMBRIDGE.—In the mathematical tripos, part i., the senior wrangler is Mr. A. S. Eddington, Trinity. The second place is taken by Mr. G. R. Blanco-White, Trinity, and the third by Mr. F. J. M. Stratton, Caius.

PROF. J. W. GREGORY, F.R.S., professor of geology in the University of Melbourne, has been appointed to the chair of geology in the University of Glasgow.

THE following honorary degrees were conferred by Dublin University on June 11:—Doctors in Science, Prof. J. Dewar, Prof. J. H. van 't Hoff, Prof. Felix Klein, Major Ronald Ross, C.B., Mr. J. J. H. Teall, F.R.S., and Prof. W. H. Thompson.

DR. T. MARTIN LOWRY has been appointed lecturer in science at the Westminster Training College. Dr. Lowry will have charge of the whole of the science work of the college, and will also supervise the scientific instruction at the Southlands Training College.

MR. R. BLAIR, secretary in respect of technical instruction for the Department of Agriculture and Technical Instruction in Ireland, has been appointed executive officer for the performance of duties in connection with the administration of the Education Acts by the London Education Committee.

MR. JOHN D. ROCKEFELLER has, says *Science*, given to the Case School of Applied Science 40,000*l.* to be used for building and equipping laboratories for physics and mining engineering. Yale University will receive as residuary legatee more than 50,000*l.* from the estate of the late Mr. W. B. Ross, of New York City. The will of the late Prof. Maxwell Sommerville provides 4000*l.* for the preservation and care of the collection of engraved gems and ethnological collections given by him to the University of Pennsylvania some years ago.

AMONG recent appointments to professorships in American colleges announced in *Science* are the following:—Prof. C. Baskerville, of the University of North Carolina, to be professor of chemistry in the College of the City of New York. At Cornell University, Mr. D. S. Kimball to be Sibley professor of mechanic arts, in charge of the Sibley shops. Dr. R. Burton-Opitz to be adjunct professor of physiology in Columbia University, with a seat in the faculty of pure science. At the University of Nebraska, Mr. G. E. Condra to be professor of geology, and Mr. H. S. Evans to be an adjunct professor of electrical engineering.

IN the thirtieth general assembly of Iowa, it is stated by *Science*, an appropriation of 10,000*l.* was made for erecting either the first of a new series of engineering buildings or the wing of a single large engineering hall at the State University at Iowa City. An additional appropriation was made for constructing a dam in the Iowa River which will yield on the average more than three hundred horse-power. This power will be used for lighting and ventilating the university buildings, besides supplying power to the various engineering shops and laboratories. An additional 1000*l.* was appropriated for the better equipment of the bacteriological laboratory. Ground will at once be broken for a new museum building to cost about 25,000*l.* The present natural science building, completed in 1885 at a cost of 9000*l.*, will be moved bodily to a new site to make room for the proposed structure. The total income of the university for the next biennium will exceed 192,000*l.*, about one-third of which must be used for building.

THE Education Committee of the Essex County Council has decided to continue, during the course of the present summer, the Saturday afternoon demonstrations on field botany and other branches of nature-study which have proved highly successful in previous years. Two rambles will be held each Saturday during the remainder of June and throughout July. While these demonstrations are organised exclusively for school teachers, they are not intended only for those who have already studied botany; any teacher is eligible who takes an interest in general natural history. The same committee has decided to hold a holiday course in the principles and practice of horticulture at the biological laboratories and garden at Chelmsford for two weeks beginning on August 8. The object of the holiday course is to assist Essex teachers to gain a knowledge of the gardening operations necessary for the successful working of school gardens. The Essex Education Committee will defray travelling expenses once to and from Chelmsford, and will, in suitable cases, make a special allowance of 12*s.* 6*d.* per week towards the maintenance of teachers fulfilling the necessary conditions.

THE annual report of the council of the City and Guilds of London Institute for the year 1903 is a gratifying record of continued progress. The high standard of the work at the Central Technical College, at the college in Finsbury, as well as at the other special schools in different parts of London subsidised by the institute, has been well maintained. From the report of the examiners in the department of technology, it would seem that there is a decided improvement in the general character of the work presented, both in the written answers and the practical exercises; the most evident faults in the written parts of the examinations being due to the candidates' imperfect knowledge of the elements of physical science and of drawing, and to their inability to express their ideas in written language. It is certain that no great improvement in the intellectual character of the answers can be looked for until the teaching in elementary schools is made more practical, and further attention is given to training in drawing and scientific method and English composition. The large percentage of failures in all the preliminary examinations is an indication of the unprepared condition of the candidates on commencing their technological instruction. What the examiners in paper manufacture say is applicable to other subjects: "Without a previous attainment to a fair standard of mental training it is impossible either that a student can do justice to the technology of the subject, or have a ready habit of reducing his knowledge to expression."

It is to be hoped that the new code for the regulation of public elementary schools recently issued by the Board of Education, containing as it does a much broader and more scientifically planned curriculum, will remedy this defect, which has for many years hampered technical education in this country. It should be added that the report contains the inaugural address to the students of the Central Technical College, by Sir Guilford Molesworth, and also the address of Sir William White at the distribution of diplomas, &c., to the students of the institute's colleges and schools.

A CONFERENCE of headmasters and headmistresses, of representatives of midland educational authorities, and others interested in secondary education was held on March 19 last under the auspices of the University of Birmingham and the City of Birmingham Education Committee. The speeches delivered on this occasion have now been published in pamphlet form. The conference discussed two subjects at separate sessions. At the first meeting attention was directed to the training of secondary teachers—to what extent it is to be carried out (*a*) in training colleges, (*b*) in the schools themselves, and how far such training must depend on Government aid. The subject for the second session was the relative weight to be given to the humanities and to science in the various stages of secondary education. The remarks of some speakers in the discussion on the training of teachers for secondary schools showed that the belief in the necessity for training is not yet universal, though much more common than a few years ago. The headmaster of Shrewsbury, criticising the oft-repeated contention that the chief business of the secondary school is to train character, appropriately said:—"Is the day-school teacher—the secondary school teacher, I mean—to devote himself wholly to the formation of character, while at the same time England is falling into the rear in the matter of commerce and in scientific methods? We may concentrate our efforts on the formation of character until we forget how much more we have to do." The discussion on the relative importance of the humanities and of science was instructive as demonstrating the wide divergence of opinion which exists on most educational problems. Men of science will be disposed to agree with Sir Oliver Lodge, who said:—"I do not much care what is taught so long as it is taught well, and so long as the pupils learn what is taught. . . . I do not believe in having schools where boys having an aptitude for science shall learn nothing else, and schools where boys who have an aptitude for letters shall have nothing but a literary education." A complete education recognises the claims both of scientific and literary studies, and gives to each of these branches of knowledge its proper place.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 28.—"On the Changes of Thermoelectric Power Produced by Magnetisation, and their Relation to Magnetic Strains." By Shelford **Bidwell**, F.R.S.

The experiments described were undertaken with the view of investigating an apparent correspondence to which the author directed attention in an article published October, 1902 ("Ency. Brit.," art. Magnetism), between the effects of magnetisation upon thermoelectric quality and upon dimensions. Reference is made to the work of W. Thomson, Ewing, Chassagny, Houllevigue, and Rhoads. Although some of the results previously recorded appear to be erroneous, it is shown that, at least for iron and nickel, there is an intimate relation between the two phenomena.

In the case of iron, the relation is not disclosed unless allowance is made for the effect of the purely mechanical compression due to magnetisation. The author pointed out in 1888 (*Phil. Trans.*, vol. clxxix. A, p. 216) that a magnetised iron bar must be subject to a compressive stress, the consequent contraction being expressed as a fraction of the original length by the ratio of the lifting power or "tractive force" to Young's modulus. The tractive force was calculated in an earlier paper (*Proc.* Roy. Soc., vol. xlvii. p. 486). If a transverse cut is made in a longitudinally magnetised bar, the magnetic force inside the gap is $B=H+4\pi I$. One portion of the bar being fixed, the force acting upon the face of the other portion is less than B by $2\pi I$, the part due to the face itself; thus the attractive force per unit area $=(B-2\pi I)I=2\pi I^2+HI$. For permanent magnets, when $H=0$, and for the special case in which each half of the bar is surrounded by a tightly fitting coil, when the term $H^2/8\pi$ must be added for the mutual action of the coils, this expression becomes $B^2/8\pi$, which is sometimes said to represent "Maxwell's stress." The stress between any two portions of a magnetised bar divided by an imaginary transverse plane is sustained by the intermolecular springs, whatever their physical nature may be, to which the elasticity of the metal is due. Taking Young's modulus in grams per sq. cm. as 2×10^9, the extrinsic contraction due to magnetisation, expressed as 10-millionths of length, is $(2\pi I^2+HI)/200g$. Curves were plotted showing change of thermoelectric power and change of length in relation to H, and it was found that, if the latter were "corrected" for mechanical stress and the scale of ordinates suitably chosen, the two curves were almost coincident; without such correction there was no correspondence. The change of thermoelectric power due to magnetisation is therefore proportional to the "corrected" elongation, but the factor of proportionality differs for different specimens and for different physical conditions of the same specimen. It is shown in the paper that the two phenomena are analogously affected by tensile stress and by annealing.

For nickel it appeared, contrary to the accepted view, that the direction of the thermoelectric force was the same as in iron—from unmagnetised to magnetised through hot—whereas the "corrected" change of length is opposite in the two metals, iron being extended, nickel contracted. But the curves for change of length and for change of thermoelectric power were, when one of them was inverted, almost exactly coincident, although no correction was made for the mechanical stress. The question then arises, Why should the correction which is indispensable in the case of iron be unnecessary for nickel? The answer is that while for iron the calculated correction is very considerable (generally, indeed, greater than the observed change of length to which the correction is applied), for nickel it turns out to be exceedingly small; thus it happens that the uncorrected and the corrected curves, if referred respectively to slightly different scales of ordinates so chosen that the two curves may be of the same height, are sensibly identical. The absence of any need for the correction in the case of nickel, where, *a priori*, it ought not to be required, tends to show that the success of its application in the case of iron is not a mere accident, and the compressive stress is consequently a *vera causa*. Some years ago the question of stress in a magnetised metal was discussed by several well known physicists in NATURE (vol. liii. pp. 269, 316, 365, 462, 533), and it seems not to be agreed whether there is in fact any such mechanical stress; whether, supposing one to exist, it is compressive or tensile, and whether it is "Maxwell's stress" or some other. The author submits that the results of the new experiments support his original view.

For cobalt no relation between thermoelectric and dimensional changes attending magnetisation could be found; if any such exists, it is disguised by some cause which has yet to be discovered.

May 19.—"On Saturated Solutions." By the Earl of **Berkeley**. Communicated by F. H. Neville, F.R.S.

June 9.—"Notes on the Statolith Theory of Geotropism. I. Experiments on the Effects of Centrifugal Force. II. The Behaviour of Tertiary Roots." By Francis **Darwin**, F.R.S., and D. F. M. **Pertz**.

The facts given in the paper prove that when the primary root is removed and a secondary root assumes its place, the tertiary roots take on the character of normal secondaries. It may be believed, therefore, that the existence of statoliths in normal tertiary roots is a provision enabling them to assume diageotropic growth in case of injury to the primary root. This, though appearing a bold conclusion,

does not involve an adaptive action different in principle from the well known assumption by secondary roots of the characters of the primary root, although it is undoubtedly a more elaborate provision, and one which seems more unlikely to be called for in a state of nature.

Geological Society, May 25.—Dr. J. E. Marr, F.R.S., president, in the chair.—On the occurrence of a limestone with Upper Gault fossils at Barnwell, near Cambridge: W. G. **Fearnsides.** The limestone is variable in thickness, and is largely made up of comminuted shells of Inoceramus. It occurs in flattened lenticles. It contains abundant phosphate-nodules. Foraminifera, fragments of lamellibranchs, brachiopods, small gastropods, echinoids, and Crustacea are abundant. The fauna is not markedly different from that of the underlying clay. A list is given which shows that this fauna has been recorded from the Upper Gault of Folkestone. As these fossils are obtained 40 feet below the upper surface of the Gault seen in the section, it is clear that the whole of the Upper Gault of Cambridge was not used up in the making of the "Cambridge Greensand."—On the age of the Llyn-Padarn dykes: J. V. **Elsden.** The paper suggests that the bulk of the greenstone-dykes of this area belong to an earlier period of eruption than has been generally assigned to them. The greater part, if not actually of Bala age, seem to have been intruded before the post-Bala crush-movements. The evidence does not exclude the possibility that some of the intrusions may be of later date. Petrographical considerations make it impossible to separate these rocks from the diabase-sills of Bala age occurring farther to the south of this area.

Chemical Society, June 2.—Dr. W. H. Perkin, F.R.S., vice-president, in the chair.—The following papers were read:—Imino-ethers and allied compounds corresponding with the substituted oxamic esters: G. D. **Lander.** A description of the ethers obtained by the condensation of various bases with oxalic esters is given.—The action of heat on α-hydroxycarboxylic acids, part i., α-hydroxystearic acid: H. R. **Le Sueur.** The principal product obtained on heating this acid is margaric aldehyde.—Ionisation and chemical combination: J. Wallace **Walker.** The author shows that the assumption now generally made that all chemical action takes place between pre-existing ions is unjustifiable, in view of the fact that reactions such as those of the alkyl haloids with various compounds in presence of aluminium chloride take place under conditions under which ionisation cannot occur. Since ionisation is frequently the result of such reactions, he concludes that, in general, combination, as the result of the operation of higher valencies, precedes ionisation or any other manifestation of the occurrence of chemical change.—Ionisation and chemical combination in liquefied halogen hydrides and hydrogen sulphide: J. W. **Walker,** D. **McIntosh,** and E. H. **Archibald.**—Some compounds of aluminium chloride with organic substances containing oxygen: J. W. **Walker** and A. **Spencer.** These two papers give descriptions of compounds and experiments illustrating the arguments advanced in the first paper of this series.—The constituents of Chaulmoogra seeds: F. B. **Power** and F. H. **Gornall.** These seeds, which are derived from the plant *Taraktogenos Kurzii*, contain a cyanogen compound which is hydrolysed by an enzyme also present in the plant or by dilute acids into prussic acid and glucose, and may be a glucose-cyanhydrin. The fatty oil contained in the seeds furnishes on hydrolysis glycerol and phytosterol, and a number of fatty acids of which the most interesting is chaulmoogric acid $C_{18}H_{32}O_2$, which appears to contain a closed ring and one ethylenic linking.—The constitution of chaulmoogric acid, part i., F. B. **Power** and F. H. **Gornall.** A number of derivatives and oxidation products of this acid are described which have been prepared as a preliminary to the investigation of its constitution.—Gynocardin, a new cyanogenetic glucoside: F. B. **Power** and F. H. **Gornall.** This substance was obtained from the seeds of *Gynocardia odorata*, formerly believed to be the source of commercial chaulmoogra oil. It is crystalline, and is hydrolysed by an enzyme also existing in the plant furnishing prussic acid as one product.—*iso*Nitrosocamphor: M. O. **Forster.** A description of derivatives of this substance.—The basic properties of oxygen. Additive compounds of the halogen hydrides and organic compounds, and the higher valencies of oxygen. Asymmetric oxygen: E. H. **Archibald** and D. **McIntosh.**—The fermentation of the indigo plant: C. **Bergtheil.** It is shown that the fermentation in the indigo vat is produced principally by a specific enzyme.—The union of hydrogen and chlorine. Action of the silent electric discharge on chlorine: J. W. **Mellor.**—Studies on ethylcarboxyglutarate, part ii., action of ethyl bromocarboxyglutarate on ethyl sodiocarboxyglutarate. Formation of ethyl carboxyglutaconate: O. **Silberrad** and T. H. **Easterfield.**—The vapour pressures of liquid mixtures of restricted mutual solubility: A. **Marshall.** The vapour pressures of mixtures of water with various organic liquids have been experimentally investigated, and the results are discussed in the light of theoretical work on the same subject by Ostwald and others.—The influence of solvents on the rotation of optically active compounds, part v., the optical activity of certain tartrates in aqueous solution: T. S. **Patterson.** The rotations of a number of tartrates have been determined in aqueous solution at various concentrations and temperatures, and the influence of the latter on the numerical and sign value of the rotation is discussed.—The nitration products of the isomeric dichlorobenzenes: P. **Hartley** and J. B. **Cohen.** The authors find that the *meta*-law of substitution is followed, except in the case of *ortho*dichlorobenzene.

Linnean Society, June 2.—Prof. W. A. Herdman, F.R.S., president, in the chair.—Mr. A. O. **Walker** exhibited (1) viviparous plants of *Cardamine pratensis*, which phenomenon was unusually manifest this year, probably due to the abnormal rainfall, and (2) a gall on the flower-bud of the same plant, ascribed to *Cecidomyia Cardaminis*.—Mr. W. T. **Hindmarsh** exhibited photographs of the following plants:—*Primula deorum*, Velen., which he had succeeded in flowering, he believed for the first time in this country; *Shortia uniflora*, Maxim., the Japanese representative of the genus, with larger flowers than the original *S. galacifolia*, Torr. and Gray, and showing a tendency to vary in colour according to exposure; and *Rhodothamnus Chamaecistus*, Reichb., noteworthy for the abundance of its flowers.—*Papers*:—On the species of Impatiens in the Wallichian herbarium of the Linnean Society: Sir Joseph **Hooker.** The introduction described the material in question, consisting of 48 ticketed specimens out of 200 known species of the genus; though few in number, these specimens foreshadow the remarkable segregation of the species in the several phyto-geographical regions of India, which has no parallel in any other large genus known to the author. The second part of the paper consists of a detailed review of each sheet of the collection, with a critical determination of the specimens. There is one previously undescribed species, for which the name *Impatiens praetermissa* is proposed.—An account of the Chætognatha collected on H.M.S. *Research* in the Bay of Biscay in 1900: Dr. G. H. **Fowler.** *Sagitta serrato-dentata* was plentiful in the epiplankton down to the zone between 200 and 100 fathoms, with a maximum distribution about 50 fathoms; in daylight it appeared to rise to the surface, independently of the actual light-intensity of the moment; at night it left the surface for rather deeper water; even on bright moonlit nights, or during or after rain, it also deserted the surface, even in light daylight. The distribution of other species was described. In handling the Chætognath population as a whole, the author showed that it was thickest in the epiplankton, that below 100 fathoms there was a sudden drop in numbers, which continued down to the lowest depth studied (2000 fathoms), except for a possible slight local rise about 600 fathoms. This result, obtained by the accurate method of closing nets, directly contradicts the conclusion of Mr. R. T. Günther, deduced from the methods of open serial nets as used on the *Oceana*, that the population is greatest in deep water, the source of error with the open nets being introduced by the specimens captured during the net's upward journey to the surface from the depth nominally studied.—The flow of fluid in plant-stems: Prof. R. J. **Anderson.**

The experiments of the author were devoted to forcing water through woody stems, but references to the work of earlier investigators are not given.

Mathematical Society, June 9.—Prof. H. Lamb, president, in the chair.—The following papers were communicated:—Note on the application of Poisson's formula to discontinuous disturbances: Lord **Rayleigh**. Poisson's solution of the equation

$$\frac{\partial^2\phi}{\partial t^2}=a^2\nabla^2\phi$$

has the form

$$\phi=\frac{t}{4\pi}\int\int\dot{\phi}_0 d\sigma+\frac{\partial}{\partial t}\left(\frac{t}{4\pi}\int\int\phi_0 d\sigma\right),$$

where ϕ_0 and $\dot{\phi}_0$ denote initial values of ϕ and $\partial\phi/\partial t$ on a sphere of radius at, and the integration refers to angular space about the centre of the sphere. When the initial disturbance is continuous at the surface bounding the initially disturbed portion of the medium, the solution may be written in the form

$$\phi=\frac{1}{4\pi}\int\int\left(t\dot{\phi}_0+\phi_0+r\frac{\partial\phi_0}{\partial r}\right)_{r=at}a\sigma.$$

It is pointed out in the paper that, when there is discontinuity, the subject of integration in the latter form becomes infinite, and it is shown by an example how the integral may be interpreted so as to yield the correct result.—Wave fronts considered as the characteristics of partial differential equations: T. H. **Havelock**. It is shown that a wave front can be defined as a surface satisfying the principal equation of the characteristics of the equation of wave motion, and that, owing to the linearity of the latter equation, there is no necessity for the continuity of the first differential coefficients of the function expressing the disturbance, provided the function itself is continuous. The theory is extended to systems of partial differential equations, and, in particular, to the equations of propagation of electric waves. An invariantive property of characteristics is proved, and is applied to the theory of wave fronts and rays in moving media.—Illustrations of perpetuants: J. H. **Grace**. The quantic of infinite order being equivalent to a power series, the perpetuants are expressed as the results of performing certain operations of differentiation upon analytic functions represented by such series. It is shown that certain ones of the known analytic functions, such as the exponential function and the Weierstrassian sigma function, are determined by the vanishing of the simpler perpetuants.—Types of covariants of any degree in the coefficients of each of any number of binary quantics: P. W. **Wood**. A method is given for determining the type forms of the complete system mod $(ab)^{\frac{1}{2}n}$. The method consists in carrying out systematically a process indicated by Jordan, and previously applied to perpetuants by Grace.—Some expansions for the periods of the Jacobian elliptic functions: H. **Bateman**.

DUBLIN.

Royal Dublin Society, May 17.—Prof. J. A. McClelland in the chair.—Mr. J. H. **Pollok** read a paper on the extraction of glucina from beryl by fusion with caustic soda, solution in hydrochloric acid and saturation with hydrogen chloride to precipitate the alumina, the glucina and iron being afterwards separated by ammonium carbonate and sulphide. Analyses of carbonates, sulphates, and chlorides were also given that differed somewhat from theory.—Mr. F. E. **Hackett** read a paper on the n-rays. Some estimations of the magnitude of the subjective effects in the dark-adapted eye are given in this paper. It was found that bodies under strain produced an effect on a phosphorescent screen which could not be assigned to eye effects or the emission of heat.

PARIS.

Academy of Sciences, June 6.—M. Mascart in the chair.—On the parallax of the sun: Bouquet **de la Grye**. An account of the mode of working up the data from the photographic plates obtained in the French expedition for the observation of the transit of Venus in 1882.—On the photography of the superposed layers which constitute the solar atmosphere: H. **Deslandres**. A discussion of the work done with the large refractor at the Yerkes Observatory in relation to earlier results, together with some suggestions as to future work.—The accidental production of an intraliberian generating layer in the roots of Monocotyledons: Gaston **Bonnier**. A wound may provoke in the roots of certain Monocotyledons the commencement of secondary formations organised in the same manner as in a root of a Dicotyledon.—The physiological action of the emanation of radium: Ch. **Bouchard**, P. **Curie**, and V. **Balthazard**. The introduction of the radium emanations into the lungs of animals gives rise to toxic effects, the dominant lesion observed on *post mortem* examination being an intense pulmonary congestion. The tissues of the animals which have died under the action of the radiations are radio-active.—The radium emanation, *exradio*, its properties and changes: Sir William **Ramsay**. The emanation which escapes from radium bromide possesses the properties of a gas; it obeys Boyle's law, can be condensed at low temperature, and possesses an appreciable vapour pressure at the temperature of liquid air. The quantities available were extremely minute, about 0·0254 cubic millimetre, but this was found sufficient to prove the relation between volume and pressure, and also to obtain the spectrum. The gas is strongly luminous, but this grows weaker with time, and at the end of a month disappears. The gas appears to belong to the argon group, and has a density of about 80. If the molecule is monoatomic, the atomic weight would be 160, from which it would follow that one atom of the emanation is produced from one atom of radium.—The action exercised by the n-rays upon the intensity of the light emitted by a small electric spark, and upon some other feeble sources of light: R. **Blondlot**. A discussion of the views of M. Jean Becquerel as to the action of the n-rays upon the luminosity of a calcium sulphide screen, and an extension to the cases of a small electric spark and of a piece of platinum foil at a dull red heat.—On the emission of the n-rays and the n_1-rays: E. **Bichat**.—On the emission of the n-rays and n_1-rays by crystallised bodies: E. **Bichat**.—On the fifth scientific campaign of the *Princesse Alice*: Prince Albert of **Monaco**.—On expressions formed of superposed radicals: Paul **Wiernsberger**.—On the movements of solids with spherical trajectories: Jules **Andrade**.—On a variant of the universal joint: L. **Lecornu**.—On the critical velocity of directable balloons: Ch. **Renard**. It is shown that a balloon of the Santos-Dumont type must become ungovernable when the velocity approaches a certain critical value.—On the kathode rays: P. **Villard**. It is shown that the properties of the magneto-kathodic rays are inverse to those of the Hittorf rays; an electric field acts on the first like a magnetic field does on the second.—On a method of measuring coefficients of self-induction: M. **Iliovici**.—On the phenomena which accompany the contemplation in a dark room of feebly luminous surfaces illuminated by special kinds of light. The case of spots of phosphorescent sulphide; the effects of anæsthetics: F. P. **Le Roux**.—On the anæsthesia of metals: Jean **Becquerel**. Aluminium and copper lose their transparency to the n-rays when the surface which receives the radiation is submitted to the action of an anæsthetic; quartz appears to possess the same property. Glass, wood, and cardboard, on the other hand, always allow the radiation to pass through.—A method for the continuous registration of the state of ionisation of a gas: Ch. **Nordmann**.—The influence of the frequency in electrolysis by alternating currents: André **Brochet** and Joseph **Petit**. The electrolytic properties of alternating currents appear to be altogether different from those of continuous currents. The results obtained depend on the frequency of the alternations.—On the use of the n-rays in chemistry: Albert **Colson**.—On the reduction of o-nitrobenzyl alcohol. General remarks on the formation of indazyl derivatives: P. **Freundler**. The principal reduction products of o-nitrobenzyl alcohol are indazyl-o-benzyl alcohol, indazyl-o-benzoic acid, and anthranilic acid.—A new method for the preparation of anilides: F. **Bodroux**. The alkyl-magnesium compound is treated with an amine, and to the product an alkyl ester is added. From this, hydrochloric acid gives the anilide in a nearly theoretical yield. Details

are given of the cases in which the method has been successfully applied.—On humic manures: J. **Dumont.**—Study of the reaction brought about by an indirect oxidising ferment (anæroxydase): E. **Bourquelot** and L. **Marchadier.**—The destruction of the chrysalis of the silk cocoon by artificial cold: J. **de Loverdo.** The destruction of the chrysalis can be effected with greater certainty by cooling than by the usual method of heating.—On the apparatus for the collection of plankton: T. **Richard.**—On the Acarophytes: M. **de Wildeman.**—On barium sulphate from Lozère: M. **Guédras.**—On the platform of the higher summits of the Transylvanian Alps: E. **de Martonne.**—On seismic phenomena in northern Africa: F. de Montessus **de Ballore.**—On a volcanic eruption which took place in Arabia near the town of Medina on June 30, 1256: M. **Houdas.**—On the fossil flora of the Antarctic regions: A. G. **Nathorst.**—On the ergastoplasmic formations of the nephridial cells of sangsue (*Hirudo medicinalis*): Louis **Fage.**—Relation between the intensity of the reflexes and the nervous organisation: Ed. **Toulouse** and Cl. **Vurpas.**—Respiration in an atmosphere the oxygen of which is considerably rarefied is not accompanied by any modification of intraorganic combustions, as measured by the respiratory exchanges: T. **Tissot.**—The injection of phloridzine in the milch-cow: Ch. **Porcher.** The effect of the injection is to increase the amount of lactose in the milk.—Researches on the causes of natural immunity of snakes: C. **Phisalix.** The natural immunity of snakes is to be attributed to the presence of a free antitoxin in the blood which neutralises the poison as it penetrates into the circulation.—The agglutination of the red blood corpuscles by colloidal ferric hydrate, sodium chloride, and by different serums: Madame **Girard-Mangin** and Victor **Henri.**

Göttingen.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), parts i. and ii. for 1904, contains the following memoirs communicated to the Society:—

January 9.—P. **Drude**: The theory of light in "active" bodies.

January 23.—O. **Wallach**: Researches from the university chemical laboratory, xiii. (1) A new instance of optical isomerism. (2) The splitting of camphorphorone. (3) On 1:2:methylcyclopentanone. (4) On isoximes. W. **Biltz**: The relation of certain inorganic colloids to fibre with reference to the theory of dyeing.

February 20.—F. **Krüger**: The theory of electro-capillarity and of drop-electrodes.

March 5.—D. **Hilbert**: Principles of a general theory of linear integral equations (part i.). O. **Blumenthal**: Remark on the theory of automorphous functions. A. **Sommerfeld**: Contributions to the theory of electrons. (1) General investigation of the field of an electron moving in any manner. V. **Hensen**: The graphical process for deriving correct curves from the results of observations. W. **Biltz**: An attempt towards the interpretation of agglutination.

March 19.—W. **Nernst** and F. **von Lerch**: On the employment of the electrolytic detector in Wheatstone's bridge.

DIARY OF SOCIETIES.

THURSDAY, June 16.

Royal Society, at 4.30.—The Origin and Growth of Ripple-Mark: Mrs. H. Ayrton.—On the Seismic Effect of Tidal Stresses; R. D. Oldham.—On Flame Spectra: C. de Watteville.—An Experiment Illustrating Harmonic Undertones: H. Knapman.—A Probable Cause of the Yearly Variation of Magnetic Storms and Auroræ: Sir Norman Lockyer, K.C.B., F.R.S., and Dr. W. J. S. Lockyer.—On the Relation between the Spectra of Sun-spots and Stars: Sir Norman Lockyer, K.C.B., F.R.S.—On the Action of Wood on a Photographic Plate in the Dark: Dr. W. J. Russell, F.R.S.—The Retardation of Combustion by Oxygen: Prof. H. E. Armstrong, F.R.S.—(1) The Specific Heat of Diamond, Graphite and Ice between the Ordinary Temperature and the Boiling Point of Hydrogen. (2) The Absorption and Thermal Evolution of Gases Occluded in Charcoal at Low Temperatures. (3) Direct Separation of the most Volatile Gases from Air without Liquefaction: Prof. J. Dewar, F.R.S.—On the Influence of the Time Factor on the Correlation between Barometric Heights at Two Stations 1000 Miles Apart: Miss F. E. Cave-Browne-Cave.—The Decomposition of Ammonia by Heat: Dr. E. P. Perman and G. A. S Atkinson.—On the Action of Radium Emanations on Diamond: Sir William Crookes, F.R.S.—*And other papers.*

Linnean Society, at 8.—Variations in the Arrangement of Hair in the Horse: Dr. Walter Kidd.—An Account of the Jamaican Species of Lepanthes: W Fawcett and Dr. A. B. Rendle—On the Blaze-currents of Vegetable Tissues: Dr. A. D. Waller, F.R S.—British Freshwater Rhizopoda: James Cash.—Notes on the "Sudd" Formation of the Upper Nile: A. F. Brown.—The Place of Linnæus in the History of Botany: P. Olsson-Seffon.

Institution of Mining and Metallurgy, at 8.—The Causes and Prevention of Miners' Phthisis: Dr. J. S. Haldane, F.R.S., and R. Arthur Thomas.—Note on an Exhibit of an Emergency Set for First-Aid Treatment of Acute Cyanide Poisoning: H. C. Jenkins.—On the Assay of Tin, and on the Solubility of Cassiterite: J. H. Collins.—Iron Ore Mining in Scandinavia: W. Fischer Wilkinson.—Note on the Crib-Setting of a Deep Level Shaft: H. D. Griffiths.

MONDAY, June 20.

Sociological Society, at 5.—On the Relation of Sociology to the Social Sciences and to Philosophy: Prof. E. Durkheim and V. Branford.

TUESDAY, June 21.

Royal Statistical Society, at 5.

WEDNESDAY, June 22.

Geological Society, at 8.—The Caernarvon Earthquake of June 19, 1903, and its Accessory Shocks: Dr. C. Davison.—The Igneous Rocks of Pontesford Hill, Shropshire: W. S. Boulton.—The Tertiary Fossils of Somaliland, as Represented in the British Museum (Natural History): R. B. Newton.

FRIDAY, June 24.

Physical Society, at 5.

CONTENTS.

THURSDAY, JUNE 23, 1904.

THE LIFE WORK OF A SCIENTIFIC ENGINEER.

Original Papers by the late John Hopkinson, D.Sc., F.R.S. Vol i., Technical Papers. Edited by B. Hopkinson. Pp. lxvi+294. Vol. ii., Scientific Papers. Pp. vii+393. (Cambridge: University Press; London: C. J. Clay and Sons, 1901.) Price 10*s*. 6*d*. net each volume.

THREE years have elapsed since the two volumes of original papers by the late Dr. Hopkinson were published, and an explanation is naturally required for such a protracted interval being allowed to elapse before the work was reviewed in these pages. Shortly after its appearance, the writer became seriously ill, and the diminished vigour that accompanied a long tedious convalescence was marked by increased requests that work should be undertaken, exemplifying apparently the anecdote of the doctor who to obtain rest doubled his fees, but only succeeded thereby in doubling his practice. Hence the performance of a duty had to be postponed again and again, and it was not until Mr. C. S. Whitehead was kind enough to bring his mathematical power to bear on a critical analysis of this collection of papers and furnish the substance of much which follows that this tardy review came to be written.

In these two volumes we have the collected works of a man eminent not merely as a scientific investigator, but also as an engineer; they constitute the record of a worker who took a very leading part in showing his fellow electrical engineers how the application of scientific theory and knowledge helped more than crude trial and error in solving some of the numerous problems with which their industry abounds. Pioneers, as a rule, have the mortification of seeing their advances overlooked and neglected by their contemporaries, but Dr. Hopkinson had the happy fortune of being spared this; indeed, his papers resemble the writings of Shakespeare in that they appear to be full of quotations.

It might have been expected that a mathematician like Hopkinson, a senior wrangler and Smith's prizeman, would have freely used mathematical processes of some complexity, a transformer, for example, offering a most tempting field for mathematical excursion. But this is far from being the case; the great majority of the processes are such as can be easily understood by anyone moderately well versed in the calculus. But it must not be supposed that all these papers are easy reading; some of them are far from it, and it often takes considerable thought to grasp their meaning.

The first volume contains the technical portion of the papers, and opens with two dealing with lighthouses, one pointing out the advantages of what are known as group-flashing lights, the other describing the optical and electrical apparatus at the lighthouses of Macquarie and Tino.

The remainder of the volume deals almost exclusively with dynamo electric machinery. In the papers reprinted therein Dr. Hopkinson first shows how the curves now universally known as the "characteristic curves" are to be plotted, and then how to extract useful information from them; how, for instance, to determine the lowest speed at which a given dynamo can produce a short arc. He then directs attention to the necessity of taking account of both colour and direction in measurements of the brightness of the electric arc. A little further on we come to two papers on dynamo electric machinery, the first of which was written in conjunction with his brother, Dr. E. Hopkinson, in 1886. In these papers, which were published at about the same time as an equally important one on the same subject by Mr. Kapp, we are shown how the characteristic may be predetermined from theoretical principles based on the equations of a magnetic circuit, and on the magnetic properties of iron as found by experiment.

The paper of 1886 is classical, for with that of Mr. Kapp it laid the foundation of the design of electric machinery. Previously the proper shape to give to a dynamo was unknown, and it was impossible to foresee what effect on the performance of a dynamo would result from altering its shape. The late Prof. Rowland advocated long, lanky-legged machines, and Mr. Edison told the writer that the most astonishing thing in his life was finding that the dynamo which he sent to the Paris Electrical Exhibition of 1881 developed about the amount of electric power that he had hoped it might give.

Next follows the ingenious and economical method of testing the efficiency of a dynamo by coupling it mechanically to another of approximately equal size, and measuring the extra power that had to be supplied from an external source to keep the combination running when one of the machines acted as a motor and drove the second, which in its turn acted as a dynamo and supplied current to the first.

In reading through these papers one cannot fail to be struck with the keen insight which their author displays in picking out the essential points needing examination in the machine under discussion, and with the beautiful methods which he employs for presenting the results of his investigations. Thus, in his papers on the dynamo, he realised that, if the machine were to be improved by scientific study, it was absolutely necessary to ascertain, not merely how much power was put into it, and how much came out in a useful electrical form, but also what was going on in the various parts of the machine itself. Others before him had considered the input and output. Dr. Hopkinson, in conjunction with his brother, took up the second, and equally important, part of this investigation, and gave the results to the world in a manner that was as simple in expression as it was novel in conception.

The papers on alternating currents are, speaking generally, more important for what they suggest than for what they actually prove. Thus, to take those that deal with the parallel running of alternators. Two lines of argument in support of the opinion that they can do so are brought forward, one a purely

analytical method, the other proceeding from a consideration of the curves of current and E.M.F. If these two lines of argument rested on independent foundations, then their mutual agreement that alternators can so run would give weight. But, unfortunately, both proofs assume that the machines give smooth E.M.F. waves of the sine form and that the armatures have no iron, or, at any rate, that their self-inductions are constant. Further, the serious difficulty arising from "hunting" of the machines is not referred to. Hence the general conclusion, "You may therefore with confidence attempt to run alternate-current machines in parallel circuit for the purpose of producing any external effect," must be regarded as at any rate a bold one.

As a matter of fact, the two machines he experimented on did run in parallel perfectly, and others have since been built to do the same, but it does not follow, and indeed it is not the fact, that all machines possess this property. Dr. Hopkinson, of course, realised the limitations of his equations; indeed, he expressly mentions some of them. Hence in making his prediction we must conclude that he was more influenced by his experimental results than by his theoretical reasoning. In the numerator of the expression which occurs at the bottom of p. 149 of this paper

$$\frac{2\pi^2}{T} \text{ should be } \frac{2\pi}{T}^2.$$

A similar criticism as regards limitation in the reasoning may be passed on the equations used at the commencement of paper No. 10, p. 156, vol. i., on "Alternate Current Dynamo Electric Machines." Here he starts with the equation :—

$$Rx = E - (Lx)^{\cdot},$$

where the dot (left out by a printer's mistake on p. 163) signifies differentiation with respect to time. But, as Dr. Hopkinson remarks, "we do not know how L may vary," and so to obtain a solution he assumes L to be independent of time, which of course is not the fact, and so, as he points out, the ordinary theory does not fully account for the facts. This criticism, however, does not apply to the remainder of this paper, which is occupied with an experimental investigation of the currents induced in the coils and in the cores of the magnets of alternate current machines by the varying currents and by the varying position of the armature. A method of determining the efficiency of alternate current machines is also given, and the result used to show that in certain cases of relation of phase of current to phase of electromotive force, the effect of the local currents in the iron cores is to increase instead of to diminish the electromotive force of the machine.

We next come to a short but important paper in which the equations which hold in a transformer with a closed magnetic circuit are given and partially discussed; and in the next paper a method of testing transformers is described and illustrated, the method being similar to that previously given for continuous current dynamos

The remaining papers in this volume, consisting mostly of addresses, do not call for special remark, except for one paragraph, on p. 249, viz., "We know nothing of what light is; we do know that it is a wave." "Is it not infinitely probable that the waves of light are none other than the electrical waves which we know must exist, and must be propagated with the observed velocity of light? And, mark, this theory demands no ether." "Whether the postulate of an all-pervading ether be, or be not, a metaphysical necessity, surely it is well for the practical man and the physicist to leave the question to the metaphysician." Here, then, waves are allowed but an ether is denied, or looked on with suspicion, and so we have apparently to imagine a wave as independent of and apart from any medium; a vibration with nothing to vibrate seems a rather difficult conception. Nor is it easy to see what the metaphysician, in the proper sense of this much abused word, has got to do with the question of an ether; the physicist in his laboratory rather than the metaphysician in his armchair would seem to be the proper man to deal with it.

The papers in the second volume may be roughly divided into three groups. The first group contains papers dealing with residual charge and specific inductive capacity, the second group papers on the magnetisation of iron and the effect of temperature, whilst the third consists of papers on miscellaneous subjects.

The accurate determination of a physical constant of any substance is always a matter of scientific interest, but great additional interest and importance were attached to Dr. Hopkinson's experiments on specific inductive capacity from the fact that, according to Maxwell, the specific inductive capacity of a dielectric ought to be equal to the square of its index of refraction. To appreciate properly the full importance of these experiments we must remember that when Maxwell's treatise appeared in 1873, Maxwell was able to write that there was only one substance, paraffin, the capacity of which was known with sufficient accuracy for a comparison. To this solitary example Dr. Hopkinson added some four different kinds of glass and nine different oils, and it is hardly too much to say that if in all these substances the above relation had been fulfilled, then Hopkinson, and not Hertz, might have been regarded as the man who first experimentally verified Maxwell's theories, although Hertz's work would still have had its great value in connection with the actual propagation of electric waves in space. Unfortunately for Hopkinson, though the relation was found to be true in the hydrocarbon oils, in the vegetable and animal oils and in the glasses it was far from being satisfied.

So far, however, from jumping to the conclusion that Maxwell was wrong, Dr. Hopkinson, in a paper written in 1878, regards it as sufficient to add the caution, "it should not be inferred that his [Maxwell] theory in its more general character is disproved," whilst in a paper written in 1881 he remarks, "It must, however, never be forgotten that the time of disturbance in the actual optical experiment is many thousands of millions of times as short as in the fastest electrical experiment even when the condenser is charged or discharged for only the 1/20,000 second."

Further, in a paper published in 1882, he suggests that a further reason for the discrepancy as regards glass may be the fact that his experiments seem to show that glass would exhibit anomalous dispersion if the spectrum could be examined below the visible rays. Yet another reason for the discrepancy also suggested itself to Dr. Hopkinson, and this was the effect of residual charge, for he regarded capacity, residual charge, and dielectric conductivity, all as ordinarily known, as parts of one continuous phenomenon, and he assumes that we may add the effects of simultaneously, or successively, applied electromotive forces, and that residual charge is proportional to the electric forces producing it. He thus gets the expression:—

$$y_t = \int_0^{\infty} x\psi(\omega)d\omega,$$

where y_t is the displacement at a time t, x the P.D. applied at a time ω before t, and $\psi(\omega)$ is a function of ω only.

The experimental verification of this formula, and the detailed examination of various substances such as glass, ice, and castor oil, from this point of view are described in two exceedingly interesting papers. The influence of temperature on the phenomena is also examined. It appears from these experiments that the value of the specific inductive capacity of a substance depends on the time of contact. Thus Dr. Hopkinson found that the specific inductive capacity of ice when measured for periods of 1/100th to 1/10th second increases both with rise of temperature and with increase of time, and its value is of the order 80, but when measured for periods such as $1/10^6$ second its value is about 3, and he adds, "We conclude that the great deviation of ice from Maxwell's law is due to residual charge, which comes out between frequencies 10,000 and 100."

We may mention here that there are some misprints in the papers just referred to. On p. 15 equation (6) $\{X\psi(t) - B\}$ should be $X\{\psi(t) - B\}$; on p. 107, in equation (8), V^2/x should be V/x; on p. 113, a slight extension of the upper radius of the lower right-hand quadrant makes it appear as if this quadrant were joined to the right-hand top quadrant; and on p. 120, $dy_t/dt = \psi t$ should be $dy_t/dt = X\psi(t)$, and the reasoning that is given relatively to $\psi(t)$ really applies to $X\psi(t)$.

The magnetic papers commence with one on the magnetisation of iron, its value being greatly enhanced by the chemical analyses which are given of the specimens experimented on. An exact definition of coercive force is given, and the ascending and descending curves are found for a large number of samples by the split bar and yoke method. Attention is also directed to the way in which a small quantity of manganese changes the magnetic properties of iron; thus iron with 12 per cent. of manganese is practically non-magnetic.

The papers dealing with the effects of temperature on the magnetic properties of iron contain some very striking results. It had long been known that iron or steel became non-magnetic when raised to a sufficiently high temperature, viz. about 780° C. This Dr. Hopkinson calls the critical temperature, and he shows that for small magnetising forces the magnetisation of iron increases with rise of temperature until it approaches the critical temperature, but, on further heating, the magnetisation very suddenly almost entirely disappears. It is also shown that as conjectured by Barrett, recalescence occurs at the critical temperature, and that the quantity of heat liberated in recalescence is comparable with the heat required to melt bodies; and, as a further proof of the connection between recalescence and the disappearance of magnetism, Dr. Hopkinson shows that no liberation of heat takes place in a non-magnetisable manganese steel when experimented on in the same way as hard steel and iron.

Most remarkable results were found with certain alloys of iron and nickel. Thus it was found that a specimen containing 25 per cent. of nickel could exist in two different and quite stable states through a range of temperature from a little below freezing to 580° C., one state being non-magnetisable, the other magnetisable. Other physical properties of this alloy were found to change with its magnetic properties; thus its mechanical strength, its extensibility, its electric resistance, its density, are all different in the two states. From the memoir attached to the first volume we learn that Dr. Hopkinson tried if other substances, such as chromium and manganese steel, would behave in a similar manner when experimented on in the same way as the nickel and iron alloy, but none of them showed any sign of becoming magnetic, although cooled in solid carbonic acid.

Next follow papers on magnetic viscosity and on the propagation of magnetisation of iron as effected by the electric currents in the iron. It will be remembered with what interest the experiments on the latter subject were witnessed, and how, when the current was sent round the coil magnetising the block of iron, the ballistic galvanometers attached to the various search coils embedded in the mass deflected with considerable intervals one after the other as the magnetisation reached their respective search coils.

Lastly come papers on the rupture of iron wire by a blow, on the mathematical theory of Tartini's beats, on the effect of internal friction on resonance, on the optical properties of a titano-silicic glass, on the quasi-rigidity of a rapidly moving chain, on the torsional strain which remains on a twisted glass fibre after release from twisting stress, on the stresses caused in an elastic solid by inequalities of temperature, and various others.

At the present time, when so much attention is being given to the development of applied education in this country, it is instructive to look back on this ideal technical teacher, this translator of abstract mathematics into concrete industrial achievements, a man who was so able that he was quite simple and modest—for only mediocrity requires "side"—who sometimes spoke of things as having happened to be carried out by himself, as if it were a matter of mere chance that they had not been originated and accomplished by anyone else. What irony of fate when so many holiday-making Alpine tourists, whose only possible claim to notice consists in their having made some ascent a little earlier in the season or gone a little higher than someone else, return scatheless year after year, that the man who was doing, and had done, great work in

the realms of engineering practice and of pure science should have been lost to the world in his prime.

Vol. i is prefaced by a memoir written by his son—the present fitting holder of the chair of engineering at Cambridge—and this memoir, which even filial love and reverence have not made too flattering, forms the best review of the life's work of Dr. Hopkinson.

W. E. AYRTON.

REMINISCENCES.

Notes from a Diary. By Sir M. E. Grant Duff. Vol. i., pp. 317; vol. ii., pp. 326. (London: John Murray, 1904.) Price 18*s*.

SIR MOUNTSTUART GRANT DUFF tells us in his preface that in these two, as in the previous, volumes of his diary he has "resolutely kept to the less serious side of life." They contain no thrilling adventures, no sensational revelations, no acrimonious attacks, no profound metaphysical discussions. They give, however, an interesting picture of the life of a distinguished and cultivated man, with side glimpses of many of the most eminent of our contemporaries both in this and other countries.

For this Sir Mountstuart has had unique opportunities. When he was going to his Governorship of Madras his friends gave him a farewell dinner. It was a gathering of which any man might be proud, and in returning thanks for the toast of the evening, he said with no less truth than good feeling that, when he was young, his ambition had been to make friends of the best and highest of his contemporaries, and that, looking round him, he felt that in this object he had succeeded beyond his most sanguine hopes.

It is probable that many of those who read the diary will fancy that some pieces might have been omitted. I remember at one of our modest X club meetings we all thought that the dinner might be shortened, so as to give us more time for talk afterwards. But when we came to details we could not agree. One suggested to omit the soup, another the fish, a third the joint, and a fourth the pudding. Finally we remained as we were: so I fancy from the present volumes one would omit the botany, another the personal details, a third the theological hints, and so on. But if anyone is disposed to regard some of the details as hardly worthy of record, let him remember how interesting it would be now if Mecænas had left us similar details of his everyday life! What a light it would throw on Roman society and Roman history!

He gives us glimpses, moreover, which show the "art of conversation" at its best. He does not condescend to scandal, or attract attention by ill-natured remarks, or while away time by remarks on the weather. As Mr. Norton says in a typical case, "Flaubert's correspondence, a new edition of Æschylus, the Chanson de Roland, the management of the London Library, Bayreuth, the Euryanthe of Weber, were only a few of the many subjects which came up during our conversation."

The book is admirably adapted for a railway journey, a holiday, or a sick room. It is full of bright sayings, of good stories, of interesting reminiscences of interesting people. It carries us from one country to another, from one society to another: from London to Switzerland and Greece, from politics to theology, from The Club to the Athenæum or the Literary Society.

Sir Mountstuart thinks, and I should not be disposed to differ, that the late Lord Derby was the wisest statesman of his generation. At any rate, probably it would be safe to say that of those who took a leading part, probably none made fewer mistakes.

The botanical notes are numerous. He mentions, for instance, on the authority of Lord Plunket, that Westminster Hall is roofed with oak from the forest of Shillelagh.

The references to zoology are less frequent.

On p. 193 he tells us that Prof. (afterwards Sir William) Flower "gave a very interesting account of the shell of a tortoise which stands in one of the passages. Its original owner was a pet of Laud's, and lived in his garden at Fulham. When he became Archbishop he took the creature to Lambeth, where it lived from 1633 to 1753, when it came by its death, thanks to the folly of a gardener, who dug it up in the middle of winter."

He quotes Aubrey de Vere's happy saying that many people mistake downrightness for uprightness, and again that some people seem to "think they serve God but by serving their neighbour right."

Among other amusing bits are Sydney Smith's dream, "I had a very pleasant dream! I dreamt that there would be in future thirty-nine Muses and only nine articles"; the description of the French coinage of 1848 by a Royalist: "Liberté—point. Egalité—point. Fraternité—point"; which was thus varied: "Liberté de faire du mal. Egalité de misère. Fraternité de Cain et Abel"; the story of an Englishman who "was being driven by a carman through some town, when he saw in front of the Post-Office what he supposed to be the Nine Muses. 'What are those?' he asked his driver. 'The twelve Apostles,' was the answer. 'The twelve Apostles!' he rejoined; 'I can only see nine.' 'Oh,' said the man, 'the other three are inside sorting the Epistles:'"

Bradlaugh's saying with reference to the old and new trades unionism: "The motto of the old Trade Unionists was 'We will!' The motto of the new Trade Unionists is 'You shall!'"

One of the most beautiful of epitaphs, that written by Wordsworth (Bishop of St. Andrews) on his wife:

> I nimium dilecta: vocat Deus; I bona nostrae
> Pars animae; moerens altera disce sequi.

The names of Gladstone, Disraeli, Salisbury, Lowe, Coleridge, Newman, Stanley, Tennyson, Browning, Dufferin, Matthew Arnold, Huxley, and Flower are among those which flit through the pages. Sir Mountstuart says that he has dealt only with the less serious side of life. In saying so he meant, no doubt, that he does not deal argumentatively with politics, science or theology. The diary brings out, however, clearly his

sympathy with science, as shown, for instance, by his numerous references to botany and his many visits to the British Museum, his reverence for religion, and his affection for his friends.

He might have made his diary more piquant, no doubt, if he had yielded to the temptation of introducing some touches of that ill-nature which, as Lord Acton once said, makes the whole world kin. It is all the more to his credit that he has made a thoroughly enjoyable book quite free from scandal or bitterness

Many little indications scattered through the whole diary show how useful and sympathetic a part Lady Grant Duff has taken in her husband's career.

AVEBURY.

THE METHOD OF NATURE STUDY.

The Ludgate Nature Study Readers. Books i., ii., and iii. Edited by J. C. Medd. Pp. 176, 204, and 215.
The Frank Buckland Reader. Edited by F. T. Buckland. Pp. 248. (London: Routledge and Sons, Ltd., 1904.) Price 1s., 1s., 1s. 3*d*., 1s. 6*d*.

THE subject of "nature study" has occupied a pretty prominent place in educational discussions for the past few years, and now, for good or evil, seems to be established as a part of the routine of most elementary schools. For good or evil we say advisedly, since the subject is pursued with mixed aims and with very varied conceptions of what it can contribute to a child's education. Some people see in the subject a means of increasing the interest in agriculture and staying the migration to the towns, others regard it from a humanitarian and æsthetic side as teaching children to be fond of plants and animals; but the true function of nature study is to provide a convenient means of teaching the child to observe and experiment and so to apply its reason to the things among which it lives. Its only justification is that by its means the child can be made to work its own mind instead of passively accepting the statements of the teacher. As soon as the child's mind ceases to be actively finding out from the real object, as soon as the personal and actual note is lost, nature study becomes a very indifferent school subject.

The want of a clear conception of the spirit in which nature study should be pursued is somewhat apparent in the little series of readers which Mr. Medd has got together; they consist of a number of typical lessons contributed by men and women engaged in teaching all over the country, among whom we recognise the best of the exhibitors at the Regent's Park Nature Study Exhibition in 1902, which was so successfully organised by Mr. Medd. The subjects range over the whole scale of natural phenomena, wind and rain, the life of animals and plants, how to keep pets, rocks and fossils. We can recommend the book thoroughly to the teacher looking round for a subject to make his own, since with a little discrimination he will find examples of how to work and what to avoid. For example, in close proximity come two lessons about rocks; at p. 165, vol. iii., Dr. G. Abbot illustrates how the teacher should proceed to study the quarries in his neighbourhood (compare also Mr. Lewis, vol. ii., p. 192), what he can show from them about the way rocks have been made, and how they lead to general ideas about the structure of the country. A few pages further on we get the contrast—a tepid extract of text-book about strata, folds, dip, strike, &c., illustrated by diagrammatic sections of Kinekulle on Lake Wener, the Bavarian Hills, and the Schiefergebirge of the Eifel! Again, in the same volume, we get a lesson giving a wholly unilluminating account of sun-dials and the apparent motion of the sun, which would leave the ordinary child dazed with east and west, hour lines and shadows. What is anyone to make of an explanation like the following:—

"Now, when the ancients found out that the reason the time of sunrise varies is because the earth's axis is tilted, it occurred to them to make the gnomon lean in the same direction. The result of this was that the shadow fell on the same hour lines at the same time of the day all the year round. What a splendid discovery!"

The next lesson is a good example of the right method; the children learn to follow the change in altitude of the sun throughout the year by marking its height on a window-pane, the motion on the floor of the shadow of a spot on the same window being also recorded at the same hour every day. Little by little, as the child absorbs facts of this kind, the motion of the earth and its consequences as explained by the teacher will begin to live in its mind.

It cannot be too often repeated that as soon as nature study leaves the path of actual observation and experiment it not only becomes valueless educationally, but it is apt to result in howlers. Popular natural histories abound in hoary untruths, some of which are handed on another stage in these pages; some again seem to be newly invented. Take the following statement, vol. iii., p. 52:—

"The experienced eye can detect at once whether any particular soil is, or is not, deficient in iron by the colour of the vegetation. Compare the grass growing on chalk downs with that in a rich, alluvial valley even in the same locality. The former is short and stunted, no matter how wet the season may be, and it never attains the deep, rich green hue of the latter, inasmuch as chalk contains very little iron, and that as an impurity."

Sciolism could not go further; we should like to *viva* the author on the meaning he attaches to the word "impurity" in this connection, but he, alas! is an inspector, born to *viva* other people!

As regards the way to treat natural history proper in the school and how to turn the child's strong instinct for collecting into the right lines, no better lessons could be found than those on insects provided by Mr. W. J. Lucas.

The fourth volume of the series consists of a selection from Frank Buckland's "Curiosities of Natural History," and makes as good a school reading book as one could wish to have. The whole series is well printed and liberally, if somewhat unequally, illustrated.

A. D. H.

OUR BOOK SHELF.

On the Location and Examination of Magnetic Ore Deposits by Magnetometric Measurements. By Eugene Haanel. Pp. ix+132 and plates. (Ottawa, Canada: Department of the Interior, 1904.)

DR. HAANEL, Superintendent of Mines to the Canadian Government, read a paper under the above title at the annual meeting of the Canadian Mining Institute in the spring of last year, which is now published in book form by direction of the Minister of the Interior.

The work is substantially an account of the Swedish method of locating by means of specially constructed magnetometers the presence of magnetic ore deposits, and of determining their strike, direction of dip, and depth below the surface.

Von Wrede, as far back as 1843, indicated the value of the magnetometer in determining the location and extent of such deposits, but the first to turn the suggestion to practical account was Robert Thalén, who, in 1879, published his work "On the Examination of Iron Ore Deposits by Magnetic Measurements." Since that time the method has been greatly developed, and convenient field instruments—the Thalén-Tiberg magnetometer and the Thomson-Thalén magnetometer—are now placed by Swedish mechanicians at the disposal of mining experts. As yet, however, the knowledge and use of these instruments have been almost exclusively confined to Sweden, although scattered references to their employment are to be met with in English mining and scientific literature.

Rücker and Thorpe, in their great magnetic survey of the British Isles, showed the value of the magnetometer in determining the presence and the contour of underground magnetic material, and they were the first to direct the attention of English geologists to the importance of this instrument in geological inquiry.

Dr. Haanel has rendered the mining profession a great service by putting together a concise account of the Swedish method and practice. By the help of this manual a properly trained mining engineer would have comparatively little difficulty in mastering the theory of the field instruments and in acquiring familiarity with their use.

Whether, however, the greater number of English mining engineers are sufficiently well trained to follow the mathematical treatment of the theory, as set forth by Dr. Haanel, may be open to doubt.

Spokil, an International Language. By Dr. Ad. Nicolas. Pp. viii+272. (Paris: A. Maloine, 1904.)

THIS work consists of eight pages of preface, of eighteen pages of "grammar," of forty-four pages of exercises, and of 203 pages of a "Spokil"-French dictionary. The language consists of two kinds of words; those borrowed from existing languages with slight modifications and those coined on a system. The system is ingenious, but, in the opinion of the reviewer, quite unworkable. To take an instance:—To the letter "P" is attached various ideas; for example, those of motion, the foot, weight and the preposition "after." Thus we find Pimo, heavy; Pino, light; for the letter n contradicts the letter m; Peme, to lead; Pene, to come; the idea of "leading" being antithetical to that of "coming"; Pleal, wood; and Plealta, absence of wood; the idea of absence or default arising from the affix "ta"; and so on. As in Esperanto, different parts of speech are distinguished by different vowels, as, for example, Arta, dirt, or a dirty object; Arte, to dirty; Arto, dirty; and Artu, dirtily. The language is in what may be termed the agglutinative stage; for we have Apafil, derived from Ap, to lead, af, off, and il, agent; the whole word means an abductor. It may interest chemists to know that the future name of butylene is to be eul vokilo; for e stands for carbon, u for hydrogen, l is terminative; vo means four, ki eight, and lo is the termination of a noun (?). English plurals in s are borrowed; likewise our classification of genders. The definite and indefinite articles are retained in the singular and plural, the latter in the plural in the sense of "the ones"; and the French "du" and "des" also appear in both numbers.

Enough has probably been said to give an idea of the character of the grammar; in conclusion, we will show what is "to serve as a model to future speakers"; it is "Zu erve di teil da les espel zoio." We do not think that that will be the fate of this artificial language. And it may be confidently supposed that the future universal language will not be invented by a Frenchman. There have been a good many attempts; and they all tend far too much towards inflection. Probably the most perfect languages from that point of view are those of the native Australians, who possess singular, dual, trial and plural, who have inclusive "we" and "they," as well as exclusive, and who indicate in half-a-dozen ways the particular position of the object designated by the word "that." The idea of an international language is an admirable one, and it will no doubt be realised, but the end is not yet come, and it is certainly not "Spokil."

The Non-Metallic Minerals: Their Occurrence and Uses. By George P. Merrill. Pp. xi+414. (New York: John Wiley and Sons, 1904; London: Chapman and Hall, Ltd.) Price 17s. net.

THE author of this valuable work is head curator of geology in the United States National Museum, and in 1901 he issued a scholarly guide to the study of the collections in the section of applied geology. Upon this guide he has founded the present work in which he brings together the widely-scattered notes and references relating to the occurrence and use of minerals of value other than as ores. Much of the information he gives is quite new, particularly in regard to the occurrence of American minerals; and the value of the work is greatly enhanced by the well-selected photographs of quarries and of striking specimens. Among these the views of the big vein between the peridotite and gneiss at Corundum Hill, North Carolina; of the quarry of lithographic limestone at Solenhofen, Bavaria; of large spodumene crystals in granitic rock, Etta Mine, South Dakota; and of quarries of bituminous sandstone in California and in Indian territory, are of special interest.

The scheme of classification adopted is as follows:—(1) Elements, (2) sulphides and arsenides, (3) halides, (4) oxides, (5) carbonates, (6) silicates, (7) niobates, tantalates and tungstates, (8) phosphates and vanadates, (9) nitrates, (10) borates, (11) uranates, (12) sulphates, (13) hydrocarbon compounds, and (14) miscellaneous, including grindstones, pumice, moulding sand, road-making materials, &c. Gems, building stones and marbles are not included in the scheme. Under each species will be found an excellent bibliography, and much interesting comment and information regarding its uses. For example, we are told that at Oberstein, on the Nahe, schoolboys' marbles are made in great quantities from limestone. The stone is broken into square blocks, which are thrown into a mill consisting of a flat horizontally revolving stone with numerous concentric grooves on its surface. A block of oak, of the same diameter as the stone and resting on the cubes, is then made to revolve over them in a current of water, the cubes being thus reduced to the spherical form in about fifteen minutes.

Of lithographic stone a series of analyses are given

showing the variation in composition, even in samples from the same locality. The only stone which has as yet been found to fill all the requirements of the lithographer's art is that from Solenhofen, in Bavaria. In the United States materials of the nature of lithographic stone have been reported from a number of localities described by the author. While, however, it was possible to get small pieces suitable for trial purposes, every locality has failed, as a constant source of supply of the commercial article. Very encouraging reports come from Canadian sources, and it is possible that a considerable lithographic stone industry may yet be developed in the Dominion.

Essais des Metaux, Theorie et Pratique. By L. Gages, Chef d'escadron d'Artillerie. Pp. 168. (Paris: Gauthier-Villars, no date.) Price 3 francs.

This little work, the sixth of the "Aide-Memoire" series on metals, by the same author, is written with much of the charming clearness of diction generally found in French metallurgical writings. There are two parts, the first on the theory of the tests and the second on practice. Considering the size of the page (convenient for the pocket), the matter is wonderfully well treated. Thus, to take the tensile test as an example, there is a general heading, Preliminary Ideas, with paragraphs (1) Period called Elastic, (2) Period of Deformation, (3) Contraction, (4) Curve of Traction. In this last is worked out from the ordinary tensile curve, showing elongation and tons per square inch on the original section, a curve showing tons per square inch on the real section, thus making plain to the student the reason for the apparently paradoxical form of the ordinary curve. The next main heading is the Law of Similitude, treated under six subheadings, the first of which, for example, considers the two permanent elongations produced during tensile testing. These two very distinct elongations are not only made clear, but methods are given for their determination, and the steps in the reasoning are worked out by simple mathematical methods where necessary. In like manner are handled such subjects as elasticity, influence of temperature, repetition of stresses, distribution of deformations, augmentation of elastic limit.

Part ii., on practice, treats in a general way of the tests applied by engineers before accepting cast-iron, steel, steel castings, &c. A short chapter gives a general idea of the kind of tests applied to metals other than the iron family. Two pages on microscopic metallography are full of wisdom, counselling caution in its use alike for specification and deduction, which might well be taken to heart by some present day advanced workers. If one remembers that the little book is of a very general nature and deals with ideas about tests and testing with few details, then it is heartily to be recommended.

A. McW.

Karl Heumann's Anleitung zum Experimentiren bei Vorlesungen über anorganischen Chemie. By Dr. O. Kühling. Third edition. (Brunswick: Vieweg und Sohn, 1904.) Price 19 marks.

So long as the lecture system of imparting information is retained, so long will the experimental demonstration remain its necessary accompaniment. It is useless to contend that a student cannot derive the advantage by seeing an experiment performed that he would were he to do it himself in the laboratory. Apart from the costliness of much of the apparatus, the difficulties of manipulation would put it beyond the power of a beginner to obtain satisfactory results, which depend, as they frequently do, on the skill and experience of the experimenter. Provided an experiment is neither merely pretty nor obviously sensational, nor lasts long enough to interrupt the train of ideas, the effect can only be stimulating to the student. But the effective lecture experiment fulfilling these conditions requires a good deal of thinking and working out, and that is why the books on lecture experiments by Heumann and Newth are invaluable to teachers whose time outside the lecture room is occupied with research or the manifold duties of their departments. The third edition of Heumann's "Anleitung zum Experimentiren" will be welcomed by all teachers of chemistry. The author, who is perhaps better known as the discoverer of the indigo synthesis, died in 1894, shortly after the second edition of his work appeared, and the task of revision has fallen to Dr. Kühling. The experiments which he has added relate to electro-chemistry, to the use of liquid air in low temperature experiments, and to Moissan's electric furnace and Goldschmidt's reduction methods for the production of high temperature reactions. Physical chemistry also claims a small share of the new edition. The increasing use of the lantern has induced the editor to introduce a chapter on optical projection which includes an account of an electric installation for the lecture room. The author has had the advantage of obtaining much valuable information from such skilled experimenters as Landolt, Fischer, Buchner, Bunte and many others, with the result that the volume has swelled to a bulk which might dismay any ordinary lecture assistant.

J. B. C.

Church Stretton. Vol. ii. *Birds*, by G. H. Paddock; *Flowering Plants*, by R. de G. Benson; *Mosses*, by W. P. Hamilton; *Parochial History*, by H. M. Auden. Pp. 205+xvii. Vol. iii. *Pre-Roman, Roman, and Saxon Archaeological Remains*, by E. S. Cobbold; *Church Architecture*, compiled by E. S. Cobbold. Pp. 124+x. Both volumes edited by C. W. Campbell-Hyslop and E. S. Cobbold. (Shrewsbury: L. Wilding, 1904.) Price 5*s.* net each.

The first volume of this instructive guide to Church Stretton, which is now complete, was reviewed in our issue for October 11, 1900 (vol. lxii. p. 571), and, as pointed out on that occasion, the first instalment dealt with the geology, macro-lepidoptera, and the molluscs of the neighbourhood. As might be gathered from the titles of the sections into which the present two volumes are divided, the completed account of Church Stretton contains all that a visitor or resident is likely to want to know. Moreover, as the volumes contain the results of local scientific research and observation by competent workers, they may be used with confidence as a guide to the natural history and archæology of the district.

In the introduction to the catalogue of the birds met with in the district of Church Stretton, Mr. Paddock directs attention to the fact that owing to the persistent persecution by game preservers, some of the larger Raptores, which formerly bred there, do so no longer, and that the smaller species are, from the same cause, rapidly diminishing in number. A similar fate has befallen some members of the Corvidæ, though to a lesser degree.

Mr. Benson's catalogue of the phanerogams of Church Stretton is conveniently arranged and exhaustive in its character. Owing to the ill-health of the compiler, this list was revised by Mr. Hamilton, who deals also with the mosses of the neighbourhood.

Fundamentals of Child Study. By Edwin A. Kirkpatrick, B.S., M.Ph. Pp. xxi+384. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) Price 5*s.* net.

"This book," we are told, "is an attempt to present, in an organised form, an outline of the new science of child-study for investigators, students, teachers, and

parents. . . . It was the original intention," of the author, "to summarise all the principal child-study investigations that have been made." But this plan was evidently abandoned at a very early stage, and we have instead the present popularly written volume, which we can heartily recommend both to teachers and parents. Its style is pleasing, and its matter fairly correct, embodying the experience of fourteen years' study and teaching in the subject. Were the contents as widely read as they deserve to be, the immense importance of child-study, as a basis for methodical teaching and rational education, would be more generally realised.

The greater part of the book is devoted to the development of instincts—a word used in an extended sense by the author to embrace the phenomena of imitation, curiosity, migration, and even æsthetics, morality, and expression. These nine chapters, together with those on heredity, individuality, and on the development of the intellect, are all admirably written, containing excellent food for the parent's reflection and stimulating the interest of the teacher in her work. It seems strange that the subject of fatigue should be relegated to the chapter entitled "Abnormalities." This latter contains some useful hints on the mental and physical defects of children, but the accompanying pathological and anatomical remarks are in several instances inaccurate and misleading. C. S. M.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Residual Affinity.

THERE appears to be a tendency among chemists to abandon their own doctrine of definite valency, and to recognise an indeterminate and fluctuating number of links connecting atoms with each other.

The electron theory of the physicist, which assigns one indivisible unit of charge to a monad, two to a dyad, &c., has therefore encountered some opposition, inasmuch as it seems to tend to harden the old doctrine of "bonds" whereby atoms were supposed to be linked only in a simple definite and numerical way, no fraction of a bond being contemplated.

Assuming this rough statement to represent something like historical truth, I have a few remarks to make on the subject.

First, the possession by an atom of a definite charge, numerically specifiable as a simple multiple of an indivisible unit, must be accepted as a physical fact.

Second, this fact corresponds with those other facts which originally led chemists to assert, for instance, that nitrogen was a triad or pentad, carbon a tetrad, &c.—a position which it would seem absurd to abandon. (Incidentally it may be noted that a monad must be either electro-positive or electro-negative, but that a tetrad need not be either, since its pairs of charges may be opposite in sign.)

Third, there is nothing in these doctrines inconsistent with the existence of fractions of a bond and any required amount of "residual affinity."

It is this last thesis that I wish briefly to develop. Indeed, in 1902, in a paper on electrons published in the *Journal* of the Institution of Electrical Engineers, vol. xxxii., p. 103, I showed how it was possible to regard ordinary mechanical cohesion on the electric theory; and likewise that it was easy to regard molecular combination from the same point of view.

In a short conversation with Prof. Armstrong, at the Mansion House recently, I realised more clearly than before where the imaginary difficulty now lies.

It has been an occasional habit with physicists when speaking of lines of force to think of a single line of attraction or elastic thread joining each negative electron to its corresponding positive charge; each unit charge, in fact, being regarded as the cut end of a line of force and nothing else. But so far as I know it has never been considered that these lines of force so interpreted were physical realities, and that one and only one line really appertained to each unit charge; though in his recent remarkable book reviewed in these columns on May 26, p. 73, Prof. J. J. Thomson goes near to assigning so great a physical reality to the lines of force as would make the number issuing from any charge a commensurable number; that is to say he begins hypothetically to regard each line of force as a discrete physical entity. But even so there is no evidence that each unit of charge ought to have assigned to it one solitary line of force, it might have a great number; though it is true that on that view it becomes a definite question how many lines of force a unit charge possesses, whereas on the ordinary vaguer view of a centre of force the influence of which is felt in all directions, any specification of number of lines is either meaningless or a mere question of convenience of measurement, like the number of miles in the circumference of the earth, or the number of cubic feet in a room: a number which is necessarily and always incommensurable.

On any view electrons are supposed to repel and to be attracted with a force varying as the inverse square of the distance, and this is only consistent with a very large number of lines of force radiating from each and starting out in every direction equally.

When opposite charges have paired off in solitude, every one of these lines start from one and terminate on the other constituent of the pair, and the bundle or field of lines constitutes a full chemical "bond"; but bring other charges or other pairs into the neighbourhood, and a few threads or feelers are at once available for partial adhesion in cross directions also, the quantitative distribution of the force being easily calculable from geometrical data.

Briefly, the charge is indivisible, it is an atomic unit (up to our present knowledge); but the lines of force emanating from it are not indivisible or unified at all. The bulk of them may be occupied with straightforward chemical affinity while a few strands are operating elsewhere; and the subdivision of force may go on to any extent, giving rise to molecular combination and linking molecules into complex aggregates, so that a quite gradual change of valency is conceivably possible, the number of wandering lines being sometimes equal to, or even greater than, the number of faithful lines—though this would usually represent an unstable condition not likely to persist.

I state the position in order that physicists who see reason to disagree with it may intervene in good time and prevent any premature acceptance of a harmonising interpretation by chemists; because so long as there is any real outstanding difficulty it is clearly best for the progress of science that diverse views should continue.

OLIVER LODGE.

On a Dynamical System illustrating Spectrum Lines.

I DESIRE to express to Prof. Nagaoka my regret at my misinterpretation of his letter to NATURE of February 25, which was due simply to my failure to find any mention there of the larger system of which he speaks. No doubt his ring is quasi-stable if the central positive charge is large enough; but is it allowable to leave out of account the rest of the system? Waiving this objection, I would point out that there are upper limits to the central charge which cannot be exceeded without making the whole system positive, or the velocity of the ring greater than that of light. It may very well be that either limit is too low to allow a stable system to be reached; the discussion of this point must be reserved for another time.

G. A. SCHOTT.

Physical Laboratory, University College, Aberystwyth.

A Correction.

IN my letter to NATURE of June 16 (p. 151) concerning the source of radio-active energy, I should of course have halved the expressions given for the electrostatic energy of an isolated electron, and for energy set free by annihilation of matter. C. V. BURTON.

Cambridge, June 18.

A WORLD-WIDE BAROMETRIC SEE-SAW.

IN the year 1902, an account was given in this Journal (vol. lxvi. p. 248) of a short period atmospheric barometric variation which appeared to be closely related to the changes in the percentage frequency of prominences as observed year by year on the limb of the sun. In a later article, which appeared in the following year (vol. lxvii. p. 224), it was shown that this barometric variation consisted really of a great see-saw between two nearly antipodal parts of the earth, the one region about India and its neighbourhood behaving in an inverse way to that of South America and the southern parts of the United States. A further study of these pressure changes has recently been communicated by Sir Norman Lockyer and the writer to the Royal Society, the object being to trace the behaviour of these variations in as many regions of the earth's surface for which observations covering a sufficient period of time are available.

For this, so to speak, classification of pressure variation types, the system adopted was to take the pressure variations over India and Cordoba as the chief types of each region, denoting those of the former by the symbol (+), and those of the latter by (−). The pressure curve of any other place was then taken and compared with each. If, for example, it was found that the curve extending over several years exhibited an excess pressure at those epochs when the Indian pressure curve was in excess, then it was classified as being similar to the Indian type and represented by a (+). If it was seen that although it was more like the Indian curve than that of Cordoba, but yet not quite the exact counterpart of India, then it was denoted by (+ ?). In a similar way pressure curves like Cordoba were classified as (−), and those more like Cordoba than India as (− ?).

In some regions the pressure variation curves were distinctly a mixture of both the Indian and Cordoba types, and it was difficult to classify them satisfactorily by the above method. The symbol adopted for these cases was (± ?). Again, there were further some curves, but very few in number, in which even this mixed type of symbol was not sufficient to exhibit the relationship of their variations to the other curves, so a special symbol (?) denoting ambiguity was used.

It may here be mentioned that the pressure curves here utilised for discussion were not always formed from the values obtained by plotting the annual means, but from the means of the groups of consecutive months in which the pressure was above or below the yearly mean value. Such a division of the year can be accurately determined for places which have a regular and pronounced annual pressure variation, such as India, and where the yearly barometric range is of far greater magnitude than any other aperiodic fluctuation. In those regions where the mean yearly curve is more misleading than otherwise, such as the case of the British Isles, the divisions according to the two seasons included in the two groups of months, April to September and October to March, were adopted.

In examining the curves for the similarity or dissimilarity of the pressure changes, it was found that the special types were apparent sometimes in the yearly curves, sometimes in those for one or other of the high or low pressure groups of months, or sometimes in both of these. It did not, however, appear to follow that, because the type was distinguishable in the yearly curves, it was necessarily apparent in both the curves of the high and low pressure months.

On the accompanying map of the world are marked the types of pressure variations in each region included in this barometric survey.

Although the above classification gives a very fair idea on the whole of the types of pressure variations from one region to another, minor peculiarities have been met with which have tended to add a certain amount of difficulty. These remarks apply principally to places in the more northern latitudes. Thus, for instance, Greenland and Iceland have been classified as of the (+ ?) type, the British Isles, Germany, and Spain of the (± ?) type, and the Azores of the (− ?) type.

While the western portion of Europe is of the (± ?) type, the eastern portion gradually assumes the (− ?) type, and this region extends not only probably to Norway and Sweden, but right across European and Asiatic Russia. The European Russian type of curve has an undoubted similarity to those of more western Europe, but there are variations which indicate that the type is more like that of Cordoba than India.

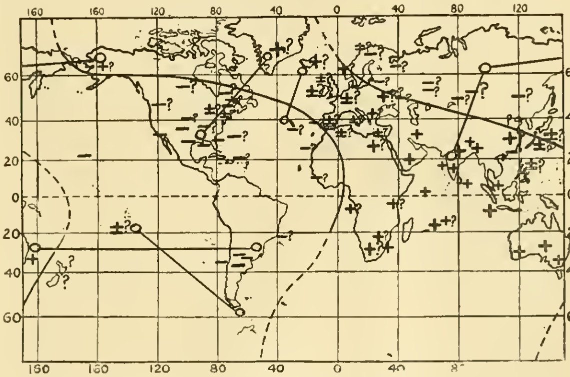


FIG. 1.—Showing the distribution of the different types of pressure variation. The two main regions are roughly separated by the neutral lines. Previously known "see-saws" are shown by the short continuous straight lines connecting the two regions marked with small circles.

Again, another region in which rather mixed types of pressures are met with is that of eastern and north-eastern Canada. Curiously enough, Prince Edward Island and Sydney (Nova Scotia) correspond very closely to the (−) type, if allowance be made for the differences about the year 1877. The inverted curve for the latter with the Adelaide (Australia) pressure curve for comparison is shown in Fig. 2.

In addition to illustrating this reversal between Adelaide (+) and Sydney (Nova Scotia) (− ?), this figure shows also, to serve as examples, curves for two other sets of reverse pressure conditions. Thus, Bombay (+) is compared with the Cordoba (−) pressure curve (inverted), and is an example of the adopted types of pressure variation. Iceland is compared with that of the Azores (inverted), and shows the reverse conditions that prevail between a (+ ?) type and a (− ?) type.

A fact to which attention was very often directed

in attempting to classify the pressure curves was that some curves, after following very closely for many years the Cordoba (−) or Indian (+) type of pressure, as the case may be, would revert back to the opposite type for a period of years. Thus, to take the case of one station alone, namely, Sydney (Nova Scotia), as an instance, the pressure curve follows very closely that of India from 1874–1882, after which, up to 1890, it has a very close resemblance to the Cordoba type. The behaviour of this Sydney (Nova Scotia) pressure curve can be compared with the Adelaide (Australia) curve in Fig. 2, but it must be noticed that the former has here been *inverted*.

The accompanying map (Fig. 1) shows the result of an attempt to indicate the position of a neutral line to illustrate approximately the mean lines of separation of these two chief pressure types, although it

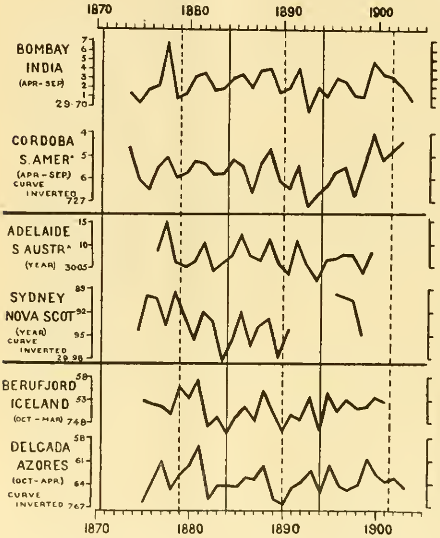


FIG 2.—Showing the two main types of pressure variation as illustrated by Bombay (+), Cordoba (−), and the barometric relationships between Adelaide and Sydney (Nova Scotia) and between Iceland and the Azores.

must be remembered that this line is liable to a probable small oscillation about its mean position.

So far as can at present be determined, one line commencing to the west of Alaska, separating this region from Siberia, passes easterly along about the 60° parallel of latitude, and runs in a south-easterly direction between south-west Greenland and north-east Canada. It then crosses the North Atlantic, passing to the north of the Azores, and skirts the south-western portion of Portugal. It then strikes down towards the Equator, cutting north-west Africa, so far as can be judged from the scant pressure values available, through the middle of the Sahara. It leaves Africa near the Gold Coast, and passes into the South Atlantic, where it cannot be traced further owing to lack of observations in this southern ocean.

The other boundary or neutral line passes to the north-east of Greenland and north of Iceland, crosses the southern portion of Norway and Sweden, and traverses southern European Russia. It then takes a course somewhat more easterly, skirting the northern part of the Caspian Sea and Turkestan, passes between Tibet and Mongolia, and through China. It then leaves the continent a little to the south of the Yellow Sea, and passes into the North Pacific Ocean. Here its path cannot be traced, but it evidently passes well to the east of the Philippine Islands, and Solomon Islands, takes a new south-westerly course, skirting the eastern side of Australia and passing between Tasmania and New Zealand. Its track is then again lost in the southern Pacific Ocean.

Although too much weight must not at present be given to the positions of these neutral lines throughout their whole length, it is interesting to note that they are fairly symmetrical to one another, although no attempt has been made to make them so. Both lines apparently cross the equator at about antipodal points, and both appear to have a similar trend in northern and southern latitudes.

The result of this survey seems to indicate clearly that there exists a general law relating to the pressure changes which occur simultaneously in these two extensive regions of the globe, separated and defined more or less by a neutral line, this latter forming a fulcrum about which see-saws of pressure from one region to another take place.

Special cases of such reverse pressure variations have previously been noticed, chief among which are those detected by Blandford, Hildebrandsson and Hann.

To illustrate these cases in relation to the present work, there have been drawn on the map (Fig. 1) small circles connected by lines to show their relation to the neutral line. A single glance is sufficient to see that in all cases except one the see-saws occur in places lying on opposite sides of the neutral line.

These results thus agree well in the main with the present distribution of the regions which have been examined.

Quite recently Prof. Bigelow, working on the same lines as those indicated in the present research, published a map of the world on which he has indicated the distribution of the pressure types according as they follow the Indian (or direct type as he calls it) or the Cordoba (indirect) pressure variations. In most of the main features, however, his map suggests a somewhat similar distribution of these pressure types to that given here. Thus, he finds that "the region around the Indian Ocean gives direct synchronism, South America and North America give inverse synchronism, while Europe and Siberia give an indifferent type. Greenland and Iceland seem to have direct type like the Indian Ocean. . . . The eastern hemisphere tends to direct synchronism, except in Europe and Russia where the indifferent type prevails, and the western hemisphere to the inverse type."

It may be mentioned in conclusion that regions which are the reverse of one another as regards these secular pressure variations should very probably experience opposite kinds of abnormal weather, while those over which the same type of pressure variation exists should have weather of an abnormal but similar nature. The intimate connection between pressure and rainfall, allowing for the local conditions as regards situation for the latter, suggests that the variation of rainfall should be closely studied in relation to this barometric surge, and it is in this way that progress may be looked for with regard to monsoon and other seasonal forecasts.

WILLIAM J. S. LOCKYER

ENGLISH FIELD-ANTHROPOLOGY.[1]

THE first organised mission sent out from this country for purely anthropological research was the outcome of Dr. Haddon's visit to Torres Straits in 1888, when he began to collect materials for a study of the natives. Ten years later, with the assistance of a fully-equipped expedition, he was able to complete the work. The reports will occupy six volumes, of which this is the first to be completed; two parts of volume ii. (Physiology and Psychology) have already appeared.

These savages constitute the ethnological frontier between Australia and New Guinea, but are distinctly Papuan. They have been in contact with white pearl-shellers and missionaries for about thirty years, and most of them are now Christianised. Though they are not a people of striking idiosyncrasy, such as the Arunta of Central Australia, and do not add to the romance of ethnology, yet this careful study of them has enriched science with several unique facts and many variations from type which will have considerable influence upon theory.

The account of the social organisation is based upon carefully revised genealogies, compiled by Dr. Rivers, which form a register of births, marriages and deaths, extending back for a hundred years. The method is an excellent one. The native system of kinship is the classificatory, with three non-essential features, which are developed in a remarkable way. The first of these is the practice of exchanging names, which seems to have been almost as common as, say, our custom of exchanging cards. The task of the genealogist was thus rendered very laborious. Secondly, the number of reciprocal terms is unprecedentedly large. Thus the term *tukoiab* denotes the relationship of brother to brother and sister to sister; it is also used and here the classificatory system appears—of all men of the same generation in the father's clan, the mother's clan, and the father's mother's clan, also of the sons of a brother and those of a sister, and of the sons of two sisters. Brothers' wives, however, are not called "wives" of *ego*; nor is there any trace of group-marriage. Polygamy was once frequent, but polyandry is unknown. The terms of relationship are also used as terms of address. In the third place we have what is perhaps the best example extant of the regulation of social duties and privileges by kinship. The division both of labour and of rights is thus harmoniously arranged. An apparently unique instance is the power of stopping fights, belonging especially to the relationship of *wadwam* (the reciprocal term for maternal uncle and nephew).

Totemism is very fully developed, both in its social and religious aspects, and has important peculiarities. Besides the principal totem a clan possesses a subsidiary one. Two important totems are crescent-shaped ornaments of tortoise-shell, with no reference to any animal or plant; they are merely decorative relics

FIG. 1.—Performer at the Saw-fish Dance, Waiben.

from the wardrobe of the hero Kwoiam, a warrior whose exploits form a considerable saga and who is more or less definitely apotheosised. These relics resemble in the powers attached to them the *churinga* of the Central Australians. But Kwoiam himself is a totem! Magical ceremonies are performed, as in Australia, to increase the supply of the totem animals as well as of the crops. An interesting feature of totemic society is the way in which the clan members try to live up to the character of their totems. The

[1] "Reports of the Cambridge Anthropological Expedition to Torres Straits. Vol. v. Sociology, Magic and Religion of the Western Islanders." Edited by A. C. Haddon, Sc.D., F.R.S., Fellow of Christ's College, Lecturer on Ethnology in the University of Cambridge. Pp. xii+378; plates xxii. (Cambridge: At the University Press, 1904.) Price 25s. net.

Cassowary men, for instance, are pugnacious, long-legged, and good runners.

Though marriage is strictly forbidden within the totem clan, its regulation belongs to kinship rather than to totemism. The phratry system, so common in Australia, seems to have formerly existed. A man sometimes lives with his wife's people, a case apparently due to circumstances which have no connection with maternal descent. The custom of the levirate is known, but it is not obligatory, and there is nothing to show it to be a survival of polyandry. It is wrong to marry an old woman. The eldest daughter is always married first. Young men rub their bodies with "sweetheart medicine" to attract the notice of the girls. It is the universal custom for the women to propose to the men.

The heads of dead persons are cured, painted and kept by the nearest relatives. It is to be noted that no worship is paid to them. Ancestor worship is unknown; the custom in question is solely due to affection. One of their funeral customs is a remarkable parallel to the ancient Roman practice; persons carefully "got up" to represent dead relatives dance at the burial.

Very interesting features are presented by the customs which have to do with property. There is no group or clan ownership of land; every inch of ground is owned by some individual. A man's property is divided at his death among his children. In default of male issue, a daughter may inherit. They have a system of leasing their gardens. If a man wants to buy a canoe he can pay by instalments with immediate possession, the *Times'* scheme being here anticipated.

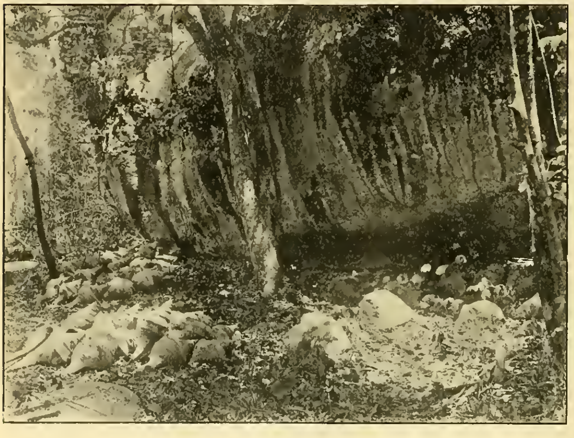


FIG. 2.—The Cave of Augudalkula in the Sacred Island of Pulu.

The account of the native religion gives an impression of incomplete study. We are told that there is no supernatural sanction for morality; even the totems are not really worshipped. We hear incidentally that the natives pray to their "heroes." An analysis of their habits of prayer would have been instructive. More information about the chief hero, Kwoiam, would have been welcome. A folk-tale speaks of the first created man: is this idea borrowed from missionaries? The concluding sentence of the volume is, "unless the above-mentioned heroes be regarded as gods, I think it can be definitely stated that the western islanders had no deities, and certainly they had no conception of a Supreme God."

We have only mentioned a few of the many facts which will assist in throwing light on old problems. That so much was done in so short a time speaks well for the energy of the expedition. But could not the hundred odd pages of folk-tales, fully reported, have been reduced? A précis of such seems adequate.

The volume is a fine monument of English anthropology, and reflects great credit on the enterprise and devotion of Dr. Haddon and his colleagues. It is by such work as this that the "science of man" is justified.

ERNEST CRAWLEY.

PROGRESS IN WIRELESS TELEGRAPHY.

IT is eighteen months or more since Mr. Marconi succeeded in establishing wireless communication across the Atlantic. On that occasion a few congratulatory messages were exchanged, a great deal was written on the subject in the Press, and the more timorous of cable shareholders were reported to be much troubled. A little later the attempt was made to demonstrate that this achievement was not merely a firework display, but was capable of direct commercial application; the Marconi Co. entered into a contract to supply the *Times* with news from America by wireless telegraphy, and for a day or so there appeared items of news in that paper under the heading "By Marconigraph." But after a few messages something went wrong, and the public were given to understand that a piece of auxiliary machinery had broken down. It is to be presumed that this piece of machinery has at length been repaired, for Mr. Marconi has once again come very much to the front with long-distance transmission work. The announcement, which we published last week, that he had been successful in maintaining a supply of news to the *Campania* on her voyage across the Atlantic with a regularity sufficient to allow of the publication of a daily paper on board that vessel affords evidence that he is still steadily pushing forward the practical development of wireless telegraphy. We have repeatedly urged in these columns that the real work of wireless telegraphy lay in communication with ships, and it is therefore a greater pleasure to record this latest development than it would be to announce the reopening of Trans-atlantic communication.

The experiments on board the *Campania* appear to have been thoroughly successful in all respects. Not only was the vessel never out of touch either with one or other of the three large power installations, but she was also for a considerable period in touch with both sides. It seems, however, that the communication was only one sided; this is, of course, only what was to be expected, but it is to be hoped that Mr. Marconi's efforts will be directed to making it reciprocal, and that before long we shall hear the announcement of this further success. It is stated that the other ships of the Cunard line are to be installed with apparatus similar to that on the *Campania*, and that a regular news service will be established to all of them. There can be no question but that this will tend very greatly to enliven the voyage across the Atlantic, and that in many other respects it will be of great practical utility.

In other directions wireless telegraphy is showing that it has won the right to consideration as a thoroughly practical means of communication. The extract from a letter from the "wireless" correspondent of the *Times* in the Far East which was printed in last week's NATURE shows to how great an extent it is being used in the Russo-Japanese war. The letter also shows that, whatever may be said to the contrary, syntonisation in the true sense is still a problem awaiting solution. The most that can be done at present seems to amount to this: a receiving station can be syntonised sufficiently well to enable it to pick up messages from a particular transmitting station in preference to, or with greater ease than, those from any other, and thus it may be enabled to work over greater ranges. It does not, however, seem in the least possible so to tune the transmitter that interception of messages is impossible, nor does it seem likely that this will ever be accomplished until experimenters have succeeded in producing continuous trains of undamped oscillations, a direction in which many are working. It is noteworthy that Dr. de Forest recently expressed the opinion that without this syntonisation is only partially possible; in this limited sense we believe all systems are making use of the principle with more or less success. The system designed by Dr. de Forest appears from many accounts to be the most efficient of those at work at the seat of war, as it has already been one of the most successful of those tried in America. The lengthy wireless messages transmitted with marked regularity in trying circumstances from the *Haimun* to the *Times* afford evidence of this, and it is noteworthy also that a speed of about thirty words a minute seems to be easily attained, which is a high speed for wireless telegraphy. The comparisons which the *Times* correspondent makes between the working of his system and that on the British warships at Wei-hai-wei, though much to the detriment of the latter, are hardly fair to the Marconi system, as the naval installations are not of the latest date.

As to the prospect of attaining thorough syntonisation, it is to be noted that Dr. de Forest is working on the lines of producing continuous oscillations on the principle of Duddell's singing arc, a method which, we pointed out in NATURE (vol. lxviii. p. 248), seemed the most promising. Others, we believe, are also working on the same lines. It is noteworthy also that much progress has been made on the scientific side, and that we are in a better position now to make quantitative measurements of the energy transmitted and received. In this connection also Mr. Duddell has contributed towards our advance; he recently exhibited before the Physical Society an instrument (which we hope to describe on another occasion) which gave considerable deflections with the currents received in the aërial wires. As this affords the first means we have of accurately measuring these currents, it may prove of great value in the development of the science.

MAURICE SOLOMON.

REPORT OF THE METEOROLOGICAL GRANT COMMITTEE.

IN December, 1902, a committee was appointed by the Treasury "to inquire and report as to the administration by the Meteorological Council of the existing parliamentary grant, and as to whether any changes in its apportionment are desirable in the interest of meteorological science, and to make any further recommendations which may occur to them with a view to increasing the utility of that grant." The committee was composed of Sir Herbert E. Maxwell, Bart., M.P. (chairman), Mr. J. A. Dewar, M.P., Sir W. de W. Abney, K.C.B., F.R.S., Sir F. Hopwood, K.C.B., C.M.G., Board of Trade, Sir T. H. Elliott, K.C.B., Board of Agriculture, Mr. T. L. Heath, Treasury, Dr. R. T. Glazebrook, F.R.S., and Prof. Joseph Larmor, F.R.S.

The report of the committee has just been published as a Blue-book (Cd. 2123, price $2\frac{1}{2}d.$), and a summary of some of the points of scientific interest in it is subjoined.

SCIENTIFIC RESEARCH.

The committee of 1877 recommended that "the council should be at liberty to appropriate a part of their annual grant to the purposes of any special researches which they may think important, and in such cases it should rest with them to select the investigators and fix the remuneration."

The council, as might be expected of a body appointed by, and reporting annually to, the Royal Society, has never lost sight of this part of its functions; but the expansion of the routine work of the office, including therein the receipt, discussion and reduction of observations, the preparation and issue of forecasts and warnings, the supply of instruments and the annual inspection of observatories, &c., has absorbed nearly the whole of the grant, leaving a comparatively trifling sum—700*l.* to 800*l.*—to be devoted to meteorological research. The council has made a strong representation that, for the effective performance of this part of its duties, the staff requires strengthening by the addition of "a few assistants specially qualified by a knowledge of mathematics and physics for undertaking the investigation of such questions as are contemplated." The additional annual cost of three such assistants, with the incidental expenses, was estimated at 2250*l.* It appears from the evidence that it would be desirable for the council to have access to a meteorological laboratory properly equipped, which would serve as one of the first-order observing stations.

We believe that the time has arrived when one of two alternatives must be taken, viz. either to provide the Meteorological Office with the additional funds necessary for the effective prosecution of independent and cooperative research, or practically to confine the functions of the Meteorological Office to the ordinary routine work. In this latter case it would be necessary to rely upon members of the council who are appointed by the Royal Society to keep abreast of the advance in meteorology which may be achieved by British and foreign scientific societies and by the Governments of foreign countries independently of the office.

We do not believe that a middle course can be pursued with any advantage. The present grant is little more than enough to maintain the office, the five observatories depending thereon, and the library, and to provide for the superannuation of the staff. It would be better to circumscribe the operations of the council to routine than to expect them to undertake investigations for which they have not adequate means.

An example of the difficulty arising under present conditions may be cited in the invitation forwarded by the Foreign Office to the council in 1902 to join in an international scheme for investigating the upper atmosphere by means of kites and balloons. The invitation had to be declined for want of the requisite 500*l.* a year.

It is clear that, from the first, it was intended that the directors of the Meteorological Office should be chosen with a view to their capacity for directing experiment and research; otherwise their appointment would not have been committed to the Royal Society. On the other hand, we perceive strong objections to granting money for scientific research in meteorology, except on the direct responsibility of a Minister of the Crown. This brings us back to the repeated recommendation of the Royal Society that the Meteorological Office should form part of one of the Government departments—a recommendation which we have included among those now submitted to your lordships.

It appears that the present constitution of the Meteorological Office was never regarded by the Royal Society as a permanent one, but as "a temporary measure till some other organisation should be carried out." We regard this as a favourable opportunity for placing the Meteorological Office upon a permanent footing.

RECOMMENDATIONS.

We are of opinion that the registration of the Meteorological Office as a company under the Joint Stock Companies' Acts should be cancelled, that the company should be wound up, and the office reconstituted as a department under the control of the Board of Agriculture and Fisheries.

The necessity for a council of seven having thus been got rid of, we recommend that the office be placed under the control of a man of science as director of meteorology, appointed after consultation with the Royal Society, but responsible to the Board of Agriculture and Fisheries, and making his annual report to that department. We recommend also the appointment of an advisory board, consisting of the hydrographer to the Admiralty, a representative of the Board of Trade, and one of the Board of Agriculture and Fisheries, and two members nominated by the Royal Society. The functions of the advisory board should be consultative only, the director being responsible to the Board of Agriculture and Fisheries for administration.

We recommend also that a second officer be appointed to act as scientific assistant to the director, to assist him in the general management of the office and in the discussion of such scientific problems as may arise.

The mean annual cost of this arrangement, as compared with that for the present council, we estimate thus:—

Present Arrangement		*Proposed Arrangement*	
Council	£850	Director £800 rising to	£1000
Secretary	625	Scientific Assistant ...	450
	£1475	Mean	£1350

The fixed parliamentary grant of 15,300*l*. should be transferred to the vote for the Board of Agriculture and Fisheries.

Under such an arrangement the anomaly would cease of what is practically a department of the public service, though nominally a joint stock company, paying for postal and telegraph services money out of its fixed income. The charge for these services would not appear in the estimate, though undoubtedly the revenue would be the loser by the amount now repaid out of the parliamentary grant. The director of meteorology would not then feel, as the council now does, that the more complete and rapid the distribution of forecasts and warnings is made, the less money remains for scientific research and for overtaking arrears in the statistical work of the department.

Further, we judge it important that the Post Office should make arrangements at the twenty-seven reporting stations in the United Kingdom for the transmission of daily telegraphic reports one hour earlier than the present one of 8.15 to 8.30 a.m., and that storm warnings should, if practicable, have priority over all private messages at all hours.

We would direct attention to the expediency of testing the efficacy of wireless telegraphy in providing advance news of weather in the Atlantic. Such news would incalculably strengthen the forecast and warning service, and might, we believe, be obtained regularly over an experimental period by cooperation either with the Admiralty, the ocean steamship companies, or both. We would urge that no unnecessary delay should take place in organising this experiment.

We recommend that in future the cost of instruments supplied to His Majesty's ships be borne upon the Navy votes, except where such instruments are intended for use in research or observation specially called for by the director of meteorology.

We consider that the premises now rented by the council are neither suitable in character nor adequate in space for the present requirements of the office, and that others should be provided wherein the staff might perform their duties under more favourable hygienic conditions, and necessary accommodation for the rapidly growing library might be secured.

We recommend that the staff employed in the library, the statistical branch and observatory branch, should be augmented. The steps necessary to give effect to this and the preceding recommendation can best be determined when the future of the office has been decided upon.

We have carefully considered the effect of our recommendations upon the apportionment of the present grant of 15,300*l*.

Our recommendations would involve a net increase of 449*l*. Another effect would be to reduce the Post Office revenue by the sum of about 2000*l*., and to transfer to Navy votes, for instruments supplied to the Royal Navy, about 500*l*.

In default of an increase to the grant, the small increased expenditure which we have recommended would have either to be postponed or to be met from economies on other branches of the work of the office.

We have not included in the figures above given any increase in the average amount of the grant allocated to scientific research, nor have we found means of providing for increased telegraph expenditure which the adoption of the recommendations as to the transmission of earlier daily telegraphic reports, and of storm warnings, will very probably entail on the Post Office.

The evidence before us has shown conclusively the importance of further scientific research, for which we trust that funds may be forthcoming in the near future.

In minority reports Sir Herbert Maxwell and Sir William Abney express disagreement with that part of the report which deals with the action of the Meteorological Council in deciding to discontinue the annual payment to Fort William Observatory, involving the abandonment of the observatory on Ben Nevis.

Mr. Dewar objects to the action taken by the council in connection with superannuation; and Sir Francis Hopwood and Mr. T. L. Heath are unable to concur in the recommendations made by a majority of the committee (*a*) in so far as they would necessarily involve an increase in the annual grant, and (*b*) in so far as they relate to the transfer of this grant from the vote for scientific investigations, &c., to that of the Board of Agriculture and Fisheries.

NOTES.

THE following announcement of a munificent gift for scientific research appeared in Monday's *Times*:—Mrs. Percy Sladen, of Northbrook Park, Devonshire, in the desire to perpetuate the memory of her late husband, Mr. W. P. Sladen, sometime secretary and vice-president of the Linnean Society, has undertaken to devote the sum of 20,000*l*. to the promotion of scientific research, particularly in the subjects in which he was chiefly interested. She proposes to assign this sum under the name of the Percy Sladen memorial fund to certain trustees, in the first place of her own appointment, who are directed to employ the income arising therefrom, in their uncontrolled discretion, to "any research or investigation in natural science, and more especially in the sciences of zoology, geology, and anthropology." They are also empowered, if they think fit, to accumulate the income for the purpose of fitting out, or assisting to fit out, any expedition designed to further such research. The following gentlemen, whom Mrs. Sladen has requested to be the first trustees, have consented to serve:—her brother, Dr. Tempest Anderson, of York; Mr. Bailey Saunders, Mr. Henry Bury, Dr. Henry Woodward, F.R.S., Prof. Howes, F.R.S., and Prof. Herdman, F.R.S. On the occurrence of any vacancy among these trustees, Mrs. Sladen reserves to herself the right to nominate their successors; but by the deed of endowment it is provided that eventually five trustees shall be severally nominated for a period of five years each by the following bodies in rotation, so far as they may have signified their acceptance of the power of appointment:—the Royal Society, the Linnean Society, the trustees of the British Museum, and the Universities of Oxford and Cambridge.

As a result of a petition in 1902 from the Johannesburg branch of the South African Association for the Advancement of Science to the Governor of the colony, a Govern-

ment observatory is now in course of erection near Johannesburg. Mr. Theodore Reunert, as honorary secretary of the South African Association, has been specially active in securing the observatory, and he is to be congratulated on the success of his efforts. His representations led to the decision to form a meteorological department as a sub-department of the Colonial Secretary's office, and Mr. R. T. A. Innes was appointed its director. The site near Johannesburg selected for the observatory is at an elevation of about 200 feet above the Bezuidenhout Valley on the south, to which it dips almost precipitously. On the north the slope is considerable, the difference in height between the summit and the northern boundary of the observatory property being about 100 feet. The summit, which includes some two acres of fairly even ground, is 180 feet higher than Johannesburg, or about 5900 feet above sea-level. The prevailing winds ensure freedom from smoke and dust. The site covers 10·6 acres, and is estimated to be worth, at the market price, 10,000*l.* at least, though the actual cost was, owing to successful negotiations, only 2500*l.* While the observatory is being built the meteorological department is lodged in the New High Court Building in Johannesburg. Arrangements have been made for the establishment of 150 observation stations at various centres of the Transvaal under volunteer observers, and from these stations observations are regularly transmitted to the director of the Government Observatory, Johannesburg.

IN addition to a number of skins of small mammals, the Hon. N. C. Rothschild has recently presented to the British Museum the entire skeleton and skin of a Nubian wild ass, obtained by himself during a sporting trip to the eastern Sudan. The skin of this wild ass (*Equus asinus nubianus*) has been set up by Rowland Ward, Ltd., and is the first entire specimen of its kind exhibited in the museum. A second specimen is, we believe, being mounted for Mr. Walter Rothschild's museum at Tring.

AN announcement of special interest was made at the meeting of the Zoological Society of London held on June 7. So long ago as 1870 the late Prof. C. Peters described, under the name of *Dinomys branicki*, a remarkable paca-like rodent of which a single example had been found some time previously wandering about the courtyard of a house in Lima. From that day until a few months ago nothing more had been heard of this strange creature, which is regarded as representing not only a genus, but likewise a family by itself. Now, however, Dr. Goeldi announces that he has specimens of this rodent living in the museum under his charge at Pará. His description of these specimens will be awaited with great interest.

AT a meeting held recently in Trinity College, Dublin, it was agreed that the great eminence of the late Provost, and his life-long connection with the university, demand a permanent commemoration in the form of some suitable memorial. A general and an executive committee have therefore been formed, and they invite the support of all graduates of Trinity College and other friends and admirers of Dr. Salmon in establishing a memorial to him. The exact form of the memorial will be decided at a meeting to be held later. In the meantime, subscriptions will be received and acknowledged by the honorary secretaries, Messrs. T. T. Gray, E. J. Gwynn, W. E. Thrift, and W. Kennedy, or the treasurers, the Right Hon. Mr. Justice Madden and the Right Hon. the Lord Justice Fitzgibbon.

A MURAL tablet erected by the Royal Institute of British Architects to the memory of the late Mr. F. C. Penrose, F.R.S., was unveiled in the crypt of St. Paul's Cathedral on Saturday last. Sir L. Alma-Tadema, who performed the ceremony, remarked that Mr. Penrose's accurate measurements revealed how far the Greeks had gone beyond the use of the straight line into comprehension of the hidden curve. He showed, for instance, that the lines of the base of the Parthenon were curved in order to appear straight, and that columns on the same plane were made different in size in order to create a more perfect and harmonious impression of uniformity. It was Mr. Penrose who directed the strengthening of the Parthenon after the earthquake of 1894. His knowledge of astronomy led him to make valuable researches concerning the orientation of ancient temples; and work of the highest importance being done to-day in Greece by a band of young excavators, who had, among other achievements, caused Crete to yield her buried treasures, was directly due to Penrose, through whom the British School of Archæology at Athens came into being.

THE death is announced of Prof. Victor de Luynes, director of the laboratory of the French Minister of Finance.

THE *Daily Chronicle* announces that Prince Albert of Monaco has taken the lead in a movement for another North Pole expedition on a plan prepared by Ensign Charles Benard, late of the French Navy. The cost of the expedition is set down at 60,000*l.*, two ships being employed.

UPON the authority of the St. Petersburg correspondent of the *Journal*, of Paris, the *Times* announces that the installation of a service of wireless telegraphy at Lake Baikal is almost complete, and will be in working order by the end of the week. It will consist of three stations, one of which will be on board the ice-breaker, which will thus be enabled to communicate with both shores during its passage across the lake.

AT the first meeting of the 1904 session of the Canterbury Philosophical Institute, held on May 4, the president, Dr. Charles Chilton, congratulated Captain Hutton on the publication of the "Index Faunæ Novæ Zealandiæ," and presented to him an album containing congratulatory addresses on the subject from the Canterbury Philosophical Institute, the Otago Institute, and from the various specialists who assisted Captain Hutton in the preparation of the "Index."

AT the seventieth annual general meeting of the Royal Statistical Society on Tuesday, June 21, Sir Francis S. Powell, Bart., M.P., was elected president for the ensuing session. It was announced that the Guy medal (silver) had been awarded to Mr. D. A. Thomas, M.P., for his paper on the growth and direction of our foreign trade in coal during the last half century, the presentation to be made in November. It was also announced that the subject of the essays for the Howard medal, which would be awarded in 1905, with 20*l.* as heretofore, was: a critical inquiry into the comparative prevalence of lunacy and other mental defects in the United Kingdom during the last fifty years

THE annual general meeting of the Palæontographical Society was held on Friday last, June 17, Dr. Henry Woodward, F.R.S., president, being in the chair. In the annual report of the council special reference was made to the activity at present prevailing among British palæontologists. The society has received more offers of monographs than it can accept for immediate publication, but it has expended more than 200*l.* of its accumulated funds in issuing an unusually large volume for 1903. Dr. Henry Woodward was re-elected president, Dr. George J. Hinde, F.R.S., was elected treasurer, and Dr. A. Smith Woodward was re-elected secretary.

At the Royal Agricultural Society's show, which was opened on Tuesday, there were in the building devoted to agricultural education and forestry a number of exhibits of interest. These came, for the most part, from the colleges where agricultural matters are taught. The Rothamsted Experiment Station sent a series of specimens of wheat and of loaves made from the flour of various samples. The results obtained, though illustrating the general experience that wheat containing much gluten yields "strong" flour that makes a big loaf, served rather to disprove the view that the quantity of nitrogenous matter present which is soluble in alcohol, or the ripeness or greenness of the corn, had any particular effect. In the bacteriological exhibit from the Midland Agricultural Institute were specimens which showed that Mr. John Golding has been able to confirm Mr. Charles Marshall's discovery (*Centralb. fur Bakteriologie*, vol. xi., April) that if in a "milk starter" an alkali-forming germ is associated with one that produces lactic acid, "ripening" of the cream takes place much more rapidly. From the same institution came a large number of hybrid potato seedlings raised by Mr. E. Miles. The agricultural section of the Essex Technical Laboratories showed some charts proving that even if the application of sulphates to the soil does not result in a larger crop, it increases its feeding value, the result being due to the larger proportion of amides which are formed. There were also specimens illustrating some new experiments showing the beneficial effects of manures upon "clover-sick" and derelict land. Very striking were the results of applying pinches of sulphate of ammonium to a lawn containing plantains; while the latter were killed, the grass and clover were affected for the better. The chief feature of the Wye College exhibits were living specimens of plants infested with fungoid and insect pests. The Agricultural Department of Cambridge, Reading College, and Harper-Adams College were also well represented, as was the Royal Agricultural Society itself. The forestry exhibition was a new feature, and in it was a representative series of specimens of timber illustrating the healing of wounds and the life-history of plants and animals injurious to trees. There were also a large number of photographs illustrating various points in forestry, together with the examples of the tools used and plots laid out with young trees.

In the Harveian Oration delivered on Tuesday at the Royal College of Physicians, Dr. Richard Caton described some results of an inquiry into the earliest records of medicine in ancient Egypt, particularly as regards the circulation of the blood and diseases of the circulation. The most interesting figure among the early physicians of Egypt was a priest of Ra, the sun god, named I-em-hotep, who lived during the third dynasty, nearly 6000 years ago, and was succeeded by a cult of priest-physicians who carried on his work of healing. Temples for the worship of I-em-hotep, which were also hospitals for the sick, arose first at Memphis, and then extended to other parts of Egypt. Here the priests not only treated the sick, but also embalmed the bodies of men and the sacred animals. In this process the heart and viscera were removed, and the priests had thus an opportunity of learning something of anatomy and of the changes produced by disease. These priest-physicians were probably the first to acquire a rudimentary knowledge of the movement of the blood. It was clear that medical science was cultivated and had advanced considerably in Egypt long before it arose in Greece. In Egypt the evidence of this fact was decisive, and in the writings of the pseudo-Apuleius it was interesting to note that Hermes told the youthful Asklepios of his predecessor, the first inventor of medicine, the Egyptian god I-em-hotep. When, in later times, Greek colonists came to Egypt, they recognised I-em-hotep as a sort of pre-existing Asklepios, and spoke of his temples as Asklepieia. The views of the circulation of the blood entertained by the Greeks were almost exactly those of their predecessors, the Egyptians; and, in view of the frequent intercourse between the two countries at that time, it was highly probable that the Greek physicians obtained their knowledge of the circulation, such as it was, from the Egyptians. The Egyptian priests seemed, in fact, to have been the first to engage in that momentous inquiry which was finally solved by Harvey, and on which the progress of medicine depended.

In the article on geodesy which appeared in Nature of June 2, referring to a contribution on the subject in the *Revue générale des Sciences*, it appears that, inadvertently, the author hardly did justice to the scientific investigations of MM. Benoit and Guillaume, the director and assistant director of the Bureau international des Poids et Mesures. The apparatus represented in Fig. 1 of our article is entirely new, and is due to the inventive faculty of those gentlemen, and not to that of M. Jäderin. That useful combination of metals known as invar is also the result of researches instituted at the Bureau International, the officers of which department may well congratulate themselves on the successful results of those investigations which they have initiated in all branches of research connected with geodesy.

The *British Journal of Photography* has just completed its fiftieth year. To mark this occasion, the editor has issued a special (jubilee) number of the journal, containing not only "the story" of the journal from its commencement to the present time, written by himself, but a series of most interesting articles by different authors on a great number of photographic topics. The *British Journal of Photography* is the outcome of the photographic energy displayed in Liverpool in the 'fifties, the first number, entitled the *Liverpool Photographic Journal*, appearing on January 14, 1854. In the "story" are given facsimiles of the title-page and the first page of this journal, and also that of the first page under the present title. Short biographical sketches of the editors and assistant editors are also included.

Dr. J. Hann recently submitted to the Vienna Academy of Sciences a work on the decrease of temperature with height up to 10 kilometres, deduced from the results of the international balloon ascents so far as they have been published. He found that the monthly means were too much influenced by the weather conditions of the days on which the ascents were made to show a tolerably trustworthy yearly range. But dealing with the *differences* of temperature for intervals of 1 kilometre, that is, with the values of the decrease of temperature with height, he was able to obtain more satisfactory and somewhat striking results. The yearly range of the differences for 1 to 3 kilometres exhibited the quickest decrease of temperature between May and June. At altitudes of 3 to 5 and 5 to 7 kilometres, the quickest decrease occurred in March and April, while at the height of 7 to 9 kilometres it occurred quite unexpectedly about the beginning of July. As first pointed out by M. Teisserenc de Bort, the decrease of temperature with height in the lower strata of air is slower in anticyclones than in cyclones, while at great heights these conditions are reversed.

Dr. Vidi, in a popular article, gives some interesting details with regard to cancer houses and districts (*Le Journal*,

Paris, May 5). One striking instance is given of a cancer district, viz. at Luckau, a small town in northern Prussia, where Behla has investigated the incidence of cancer from 1878 to 1899. The town consists of two portions, one on higher ground, which is well drained and consists of 415 houses, the other low-lying, damp, and surrounded with canals, consisting of 115 houses. In the latter, during the twenty years, seventy-five cases of cancer occurred, while in the former, nearly four times as large, only sixty-five cases occurred during the same period.

ON a previous occasion reference has been made in our columns to the investigations of Dr. C. H. Eigenmann into the structure of the eye of the blind fishes (Amblyopsidæ). A fuller and more detailed memoir by the same investigator on the eye of Amblyopsis has recently been published in *Contributions* from the Zoological Laboratory of Indiana University (No. 50). The author finds that although the foundations of the eye are normally laid, instead of developing with the aid of new material, the superstructure is completed out of that provided for the foundation, and that in the end complete disintegration takes place.

WE have received from the U.S. National Committee of Audubon Societies a batch of leaflets (published at New York) on bird protection and on the teaching of ornithology in schools, and likewise the combined report of that body and the A.O.U. Committee on the Protection of North American Birds for 1903, extracted from the *Auk* for January. The leaflets contain excellent portraits and descriptions of some of the most beneficial of North American birds, one being specially devoted to the snowy heron, or egret, and to the oft-told tale of the iniquity of wearing "aigrettes" and "ospreys." The report, which is illustrated with reproductions from photographs of bird life in protected localities, emphasises the satisfactory results which have accrued from the special protection extended to gulls and terns by means of the Thayer fund.

IN his usual interesting style, Mr. E. T. Seton, in the June number of the *Century Magazine*, gives an account of the labours of the little burrowing rodents commonly known as pocket-gophers, and their effect on the soil. According to the author's personal observations, true earth-worms are unknown in Manitoba, and, indeed, in all that part of North America lying to the south of the Saskatchewan and west of the Mississippi, with the exception of a narrow humid belt along the Pacific coast; and it would seem that the work performed by those annelids in other parts of the world is accomplished in western North America by pocket-gophers. In Manitoba the surface soil consists of a layer of black humus from a foot to two feet in thickness, and there can be little doubt that this layer, which is not a solid bed of decayed vegetation, has been thoroughly mixed up with the subjacent loam by the action of burrowing rodents, foremost among which are pocket-gophers.

APPENDIX iii. to the Kew *Bulletin* has been received, which contains a list of the new garden plants of the year 1903.

IN the *Journal* of the Asiatic Society of Bengal, No. 4, vol. lxxii., Sir George King, F.R.S., in conjunction with Mr. J. S. Gamble, F.R.S., continues the "Materials for a Flora of the Malay Peninsula." The contribution contains the order Caprifoliaceæ (three species of Viburnum), and those species of the Rubiaceæ which possess numerous ovules in each cell of the ovary. This tropical order is well represented, and the authors have added a number of new species, including fourteen for Argostemma, nine for Randia, and four for the morphologically interesting genus Mussænda.

THE subject of nuclear fusion in vegetative cells is treated in three papers by Dr. Nemec which have appeared in the *Sitzungsberichte* of the Royal Scientific Society of Bohemia (1902, 1903). By the action of such irritant solutions as copper sulphate or chloral hydrate, it is possible to induce anomalous developments in the cells of the meristematic region of seedling roots whereby the formation of the cell wall consequent to cell division is suspended, and a bi-nuclear condition is established. Fusion of the two nuclei follows, and the resulting nucleus in the succeeding division shows twice the ordinary number of chromosomes. This number is maintained for a time, but eventually a reduction takes place, and the ordinary number of chromosomes appear on the spindle.

WE have received from Messrs. Armbrecht, Nelson and Co. a fine example of flexible sandstone, known also as itacolumite, from its occurrence on Itacolumi, a mountain near the town of Ouro Preto, in the State of Minas Gereas in Brazil, where it was first discovered. This variety of rock has been found in several localities in the United States, and also in India. Examples were obtained by the late General C. A. McMahon from Kaliana, a hill near Dadri, about 60 miles west of Delhi. He regarded it as a local and modified form of the quartzite of the district. Certain beds of earthy cellular quartzite are there quarried for millstones, and the stone-cutters come abruptly upon the flexible stone when engaged in quarrying. This stone occurs in irregular patches, and its flexibility appears to be due to the partial removal of the felspathic cement to which the rigidity of the mass of the adjacent rocks is due. The rock does not possess a schistose structure, and the flexibility is not due to the presence of talc or mica, the peculiar character being due to the decomposition or dissolution of portions of the matrix of the quartzite.

PROFESSIONAL paper No. 9 (forestry series) of the United States Geological Survey deals with the forest conditions in the Cascade Range Forest Reserve, and forms the sixth paper of the series. A description of the first five papers will be found in NATURE, vol. lxviii. p. 406. The Cascade Range Forest Reserve covers an area of 7254 square miles, and is the largest of all the reserves. The introduction deals with the general topographical, geological, and climatic features of the area, the classification of lands, such as forested, burned, open, &c., together with the total stand of timber, which exceeds 50,000,000,000 feet. The species are varied, although the timber consists almost entirely of conifers. The reserve is divided into thirty-seven townships, which are again subdivided into ranges. The bulk of the report deals with the classification of lands, stand of timber, species, and forest conditions in the several ranges. The value of the report is greatly enhanced by the forty-one illustrations, consisting of photographs, maps, and diagrams.

WE have received from Messrs. A. and J. Smith, of Aberdeen, a descriptive catalogue containing full particulars of Prof. Hay's apparatus devised for the investigations conducted by Dr. Leslie Mackenzie and himself for the Royal Commission on Physical Training. In addition, the list contains information of other appliances suitable for the measurement of children.

THE most recent addition to the Patent Office Library Series is the "Subject List of Works on Electricity, Magnetism, and Electro-Technics, in the Library of the

Patent Office," which costs sixpence. The list consists of two parts; first, a general alphabet of subject headings, with entries in chronological order of the works arranged under these headings, and, secondly, a key, or a summary of these headings shown in class order. The list comprises 2374 works, representing 3792 volumes.

THE series of eight lectures on "Physical Chemistry and its Applications," delivered some time ago by Prof. J. H. van 't Hoff at the invitation of the University of Chicago, has recently been translated into French by Prof. Corvisy (A. Hermann, Paris). No higher tribute to the intrinsic merit of these most readable lectures could be desired, and they will no doubt be warmly received by a large circle of French readers.

SOME noteworthy experimental results communicated by Messrs. van Calcar and Lobry de Bruyn to the current volume of the *Recueil des Travaux chimiques des Pays-Bas*, vol. xxiii. p. 218, show that considerable changes take place in the concentration of solutions under the influence of centrifugal forces. The concentration increases from the axis of rotation towards the periphery, and the changes have been accurately measured in the case of potassium iodide and cane sugar. Portions of a solution of potassium iodide of 0·2035 normal concentration, removed respectively from points near the axis of rotation and some distance away, were found to be 0·1065 normal and 0·325 normal. These portions of solution were removed after centrifuging for three hours at the rate of 2400 revolutions per minute. A saturated solution of Glauber's salt, containing 8·8 per cent. Na_2SO_4, deposited 57 grams of solid $Na_2SO_4.10H_2O$ at the periphery after being rotated for five hours, and the remaining solution was found to contain only 5·5 per cent. of sodium sulphate. It is calculated that the applied force acting on the molecules at the periphery (radius of rotation = 6 cm.) in these experiments was more than 400 times greater than gravitational force.

IN the *Revue de Metallurgie* for April, M. H. Le Chatelier re-states and explains his views on the constitution of the carbon-iron alloys. He points out the importance of classifying the constituents of heterogeneous bodies, and again directs attention to the similarity between alloys and igneous rocks. In chemical classification it is necessary to give the chief place to the conception of phases, and to regard chemical composition as of secondary importance. If chemical composition alone were used for purposes of classification, there would be no distinction, for example, between crystallised granite and fused granite, although the former contains three phases, quartz, felspar and mica, and the latter contains only one phase. Moreover, it is desirable to give names to the phases, even when they are solid solutions of variable composition. One of the great difficulties in determining the phases in the steels is that the individual crystals are generally so minute that they cannot be isolated, and their properties and chemical composition cannot be exactly determined. Nevertheless, some progress has been made in the recognition of the various phases that may occur. M. Le Chatelier believes that these phases include iron in its various allotropic forms; carbon in the form of graphite; cementite, or Fe_3C; and many solid solutions containing iron and either carbon, nickel, manganese, phosphorus, silicon, or other elements. Most of these phases have not yet received names, but the highly important carbon-iron solutions have been called troostite, martensite, and austenite. The homogeneity of these phases has been called in question, but the attempts to prove that they are heterogeneous have not yet been successful. Difficulties are occasioned by the similarity of the properties of these three solutions, and the evidence that they are distinct rests mainly on their appearance under the microscope after treatment by different reagents. It is scarcely necessary to add that these views are not shared by some students of metallography.

OUR ASTRONOMICAL COLUMN.

THE GOVERNMENT OBSERVATORY, BOMBAY.—The report of the Bombay Observatory for the year ending December 31, 1903, signed by the director, Mr. N. A. F. Moos, gives an account of the many and varied observations carried out there. The instrumental equipment is extensive and in good order, the records of failure by the automatic registering instruments being very few.

The rainfall for the year was 84·49 inches, a surplus of 9·33 inches above the average of the twenty-four years 1873–1896. The daily wind pressures and temperatures were recorded regularly, and many magnetic and seismographic observations were made daily. Routine observations with the transit instrument, to check the standard clocks, were made at regular intervals, and a very good time service was maintained at the docks and other public places. The rating and adjustment of chronometers and deck-watches for Government departments and ships, and for private ship owners, formed an important part of the year's work.

NEBULOUS AREAS OF THE SKY.—In an article published in *Popular Astronomy* (No. 6, vol. xii.), Prof. H. C. Wilson, of the Goodsell Observatory, discusses the subjective existence of the large nebulous areas of the sky as described by Sir William Herschel. He fully confirms Herschel's observations, and considers that the negative results obtained by Dr. Roberts last year must have been due to unfavourable observing conditions. Further, he shows by a reproduction of one of his own beautiful photographs of the Pleiades region, which was taken with a 6-inch Brashear star-camera, that at least one of the regions described by Dr. Roberts as containing no nebulosity is in reality filled with nebulous matter, covering as many square degrees as Herschel allotted to the whole of the nebulosities in his fifty-two regions.

Profs. Wilson and Payne intend transporting their photographic equipment to a station situated in the western Montana mountains at an altitude of about one mile, so that during July and August they may test the suitability of the atmosphere at that altitude for photographing the nebulous patches of the Milky Way, and, if possible, obtain further confirmatory photographs of Herschel's regions.

LIGHT CURVE OF δ CEPHEI.—From an exhaustive discussion of the available data concerning the magnitude variations of δ Cephei, M. Beliawsky, of St. Petersburg, has derived the following elements:—

Minimum 0 = 1840 September 24·833d. M.T. Bonn.
Period = 5·36642 days.

The period between a maximum and the succeeding minimum, according to the curve, is 1d. 11·184h., and this value is very near the mean of the values obtained by five previous workers. The light of the star varies between magnitudes 4·37 and 3·57, and M. Beliawsky gives the estimated magnitude for every 0·1 day between two succeeding minima (*Astronomische Nachrichten*, No. 3952).

POSITION OF THE AXIS OF ROTATION OF MARS.—*Bulletin* No. 9 of the Lowell Observatory gives the results of a new determination of the position of the axis of rotation of Mars, made by Mr. Lowell. The direct method was employed, the position angle of the tangent to the limb at the nearest point to the polar cap being measured with a micrometer. The varying inclination of this tangent to the horizontal renders necessary the tilting of the observer's eyes in some positions; presuming that this might affect the resulting measures, Mr. Lowell has differentiated the results accordingly, calling them "expurgated" or "unexpurgated" as the time of observation was less or more than three hours after the horizontal position of the tangent.

This was found to make less difference to the final result than that caused by observing the different oppositions.

The results obtained for the position of the pole of Mars are as follows:—

	R.A.	Dec.
Position upon the earth's equator...	315° 32′	54° 51′
Intersection of the Martian equator and Martian ecliptic	85° 56′	24° 32′
Inclination of Martian equator to Martian ecliptic	—	22° 55′

THE STRUCTURE OF METALS.[1]

THE subject of the lecture was the structure of metals, mainly as revealed by the microscope. The first serious application of the microscope to the study of metallic structure was made in 1864 by Dr. H. Sorby, of Sheffield, but the lead then given was not followed for nearly a quarter of a century. In the last fifteen years or so, however, it had been taken up with the greatest zeal and success, nowhere more than in Dr. Sorby's own town. There and elsewhere, in France, Germany, and America, as well as at home, a band of enthusiastic workers had been engaged in creating what might be described as a novel branch of physical science, as interesting on the physical side as it was important in its practical aspect. In this work Cambridge had done its share. The lecturer referred especially to work done in the engineering laboratory by Rosenhain, Humfrey, and other of his own former research students, and to the admirable investigation of alloys carried out by Neville and Heycock in the laboratory of Sidney Sussex College.

It was only possible to give in a single lecture a very brief account of part of this work. Photography had lent its powerful aid in recording what the microscope made visible. By means of lantern slides showing microphotographs of polished and etched metallic surfaces, the lecturer proceeded to exhibit the characteristic structure of a pure or nearly pure metal, where the whole mass is made up of irregular grains with well marked boundaries more or less polygonal in form. The grains could be distinguished from one another not only by the presence of the boundaries, but by differences of texture which were especially conspicuous under oblique lighting. Each grain was a true crystal made up of similarly oriented particles in a perfectly regular tactical arrangement, such as might be exemplified by imagining it to be built up of minute brickbats all of the same form and size. When a polished surface was etched the facets of the elementary brickbats were exposed, and the manner in which these reflected the light into or away from the microscope determined the appearance which the grain presented under oblique illumination. A slight change in the direction of the incident light would greatly affect the brightness of the grain, making it shine out or grow dull, but over each grain there was a uniform degree of brightness due to the uniformity of its tactical formation. Each grain had grown as a crystal, starting from a chance nucleus, and the boundaries were determined by the casual interference of grain with grain in the process of growth. In general, the growth was at first dendritic, skeleton forms shooting out until they met similar growths in neighbouring grains, and the interstices of the skeleton were filled in later. In some metals the grains were products of crystallisation from the liquid state; in others, notably in iron, a re-crystallisation took place long after the metal had solidified, and in such cases the grains, as we knew them under ordinary conditions of temperature, were the result of an internal re-arrangement which took place while the metal was solid. In such cases they were characterised by less regular boundaries, and there was evidence of more intimate interlocking between grain and grain. The structure might be fine or gross; in specially pure metals, and under specially slow conditions of cooling, it was apt to become specially gross. An instance was exhibited of a piece of lead of exceptional purity allowed to solidify by very slow cooling, in which the grains were so large as to be visible to the audience without magnification. Their appearance under oblique lighting was projected on the screen, and by tilting the block of lead the striking changes of brightness due to change in the incidence of the light were exhibited. Other evidences of the crystalline character of the grains were referred to, namely, the pits and geometrical forms developed on the surface by etching, and the geometrical forms assumed by very minute bubbles of gas or air imprisoned in the process of solidification.

Coming next to the consideration of effects of stress, the lecturer described the experiments by which, in conjunction with Mr. Rosenhain, he had demonstrated that the plastic yielding of metals when severely strained is due to a multitude of slips occurring along cleavage planes in the several grains of which the metal is a conglomerate. The appearance of "slip-lines" in various metals was shown, and the character of the lines was discussed. As Rosenhain had recently pointed out, the slip-lines were comparatively straight in grains formed by solidification from the solid (as, for example, in cast lead, silver, and gold), but were broken up into steps which gave them the appearance of being curved in metal which had undergone re-crystallisation while in the solid state. This was ascribed to the more intimate interlocking of the grains in the latter case. That the slips showed themselves by steps or sudden slight changes in the level of the surface was clearly demonstrated when the slip-lines were examined under oblique light. All the parallel slips on a given grain would then flash out simultaneously when the direction of the incident light suited the particular slope of the planes in which the slips had taken place. The form of slips in twin structures was exhibited, and also in an example (due to Humfrey) of lead with a structure so gross that the relation of the slips to the geometry of the grain could be readily traced.

A question of immense practical interest was the "fatigue" which metals underwent when exposed to many repetitions of a straining action. The microscope threw valuable light on this by showing how, under repetition of pulls or pushes or bendings, a piece began to give way, first by slips appearing on isolated grains, and then by some of these slips gradually developing into cracks. Instances were cited from a joint research by the lecturer and Mr. Humfrey. Mr. Rogers, who had pursued this subject with much zeal, had recently found that breakdown by fatigue was much more liable to occur in steel which had been thermally treated in such a manner as to develop a comparatively large structure than in the same steel when the treatment was such as to make the structure normally small.

Going on to speak of alloys, the lecturer described shortly the various ways in which two constituents might combine, or rather act together, in the composition of a binary alloy. In the liquid state each dissolved in the other, in the solid state one might remain wholly or in part dissolved in the other, forming what was called a solid solution. Thus with two constituents A and B, if A were present in small quantity only it might be found wholly contained as a solid solution in B. More generally, however, a solid solution would crystallise out first, leaving a mother liquor richer in A, which, by throwing down more and more solid solution, finally reached the proportion of the "eutectic" alloy, and then solidified as a eutectic mixture, showing under the microscope the zebra-like marking which characterised eutectic alloys. This process was explained by means of freezing-point curves, and was exemplified by a beautiful series of photographs taken by Mr. Stead, showing alloys of various proportional composition in which iron and phosphide of iron were the two constituents. When very little phosphorus was present, the whole solidified as a solid solution showing grains undistinguishable in general appearance from those of a pure metal. With a little more phosphorus the solid still consisted mainly of large grains, but the interstices (or in one case the inner parts of a dendritic skeleton) showed traces of the eutectic, which was the last part to solidify. With more phosphorus still the solid solution showed itself as incomplete skeleton grains interspersed with large quantities of eutectic. With more still the eutectic proportion was reached, and the whole solidified as a eutectic mixture, showing zebra markings all over the surface. With more still—that is to say, with an excess of phosphide—crystals of phosphide were first

[1] Abstract of the Rede lecture delivered before the University of Cambridge, June 11. By J. A. Ewing, LL.D., F.R.S., Hon. Fellow of King's College, Director of Naval Education.

deposited, and the remainder froze as a eutectic in which these crystals were encased. The phosphide crystals showed sharp geometrical outlines, in marked contrast to the outlines of the crystals of solution, because the phosphide was deposited as a definite constituent in which the other constituent (iron) was not soluble.

To explain the zebra markings characteristic of eutectics, Dr. Ewing briefly referred to the phenomenon of surfusion, and gave it as his opinion that the formation of a eutectic occurred by alternate surfusion or supersaturation of each constituent in the other. A eutectic in the fluid state and about to freeze might be defined as a saturated solution of A in B which was at the same time a saturated solution of B in A. On the temperature falling, an alternating condition of instability results. By surfusion, A is at first supersaturated with B, until some of B is thrown down, leaving, in the liquid that remains, B supersaturated with A. Consequently, some of A is in turn thrown down, and so on alternately. In the appearance of a eutectic alloy there was much that was suggestive of alternate deposit of the two constituents, and it was in some such way as this that Dr. Ewing conceived the alternation to take place.

Eutectics in which the constituents were not of the same crystalline system appeared to be mechanically weak. A very small quantity of bismuth added to copper or silver or lead was shown by Arnold to produce great brittleness, owing to the weakness of the cement which the eutectic formed in the joints between the grains, although the individual grains themselves preserved their original malleability. In other eutectics no such weakness, as a rule, was found, and the intergranular cement was as strong as the grains themselves—often, indeed, it was distinctly stronger.

From the engineering point of view, by far the most important alloys were those in which the chief constituents were iron and carbon, or rather iron and carbide of iron. By help of Roozeboom's diagram, the lecturer explained briefly the characteristics of high and low carbon steels, and the transformations which occur in the process of cooling at temperatures far below that at which the metal becomes wholly solid, which had formed the subject of much study by Osmond, Roberts-Austen, and others. By the process of quenching these changes might be to some extent arrested, and the mechanical properties secured which characterise hardened steels. The evolution of heat in the transformation was illustrated by means of cooling curves, and by experiments in which steel wire was allowed to cool after being electrically heated above the transformation points. While passing through the region in which transformation occurs, the steel is specially plastic; this was illustrated in the cooling from bright redness of a steel wire coiled into the form of a spring and carrying a light weight. The spring extended in a conspicuous way while the process of re-crystallisation associated with "recalescence" was going on. The phenomenon of recalescence was further illustrated in an automatic record obtained during the lecture with a Callendar recorder which was exhibited by the Cambridge Instrument Company. The recent results of Carpenter and Keeling, in their research at the National Physical Laboratory, were referred to as giving in most particulars a general confirmation of Roozeboom's views. Other examples of transformation occurring in the solid state were illustrated by photographs selected from Neville and Heycock's series for the copper-tin alloys.

The gradual changes of structure which go on even at atmospheric temperatures in lead and other metals after the structure has been broken up by severe straining were next described, photographs by Rosenhain and the lecturer being exhibited to demonstrate the progressive character of these changes, and the manner in which they would be accelerated by elevating the temperature.

In conclusion, the lecturer referred to the analogous case of glacier ice. It had for long been known to possess a granular structure, and each grain was a crystal just as in the case of metals. Photographs by Principal Skinner, illustrating this granular structure, were shown. In the upper névé the grains were vague and comparatively small; as the glacier slowly travelled down the grains became consolidated and large, and their outlines became well defined. It was clear that a slow process of crystal growth was going on, and in the lecturer's opinion it was to this very process of growth that the plasticity of the glacier as a whole was to be ascribed. How ice came to be plastic in large masses was a question to which physicists had suggested more than one answer. But the plasticity was intelligible enough when one realised that the whole mass was in the act of structural change. Just as the spiral spring in the experiment with steel showed during its transformation a special plasticity, so the glacier showed a general plasticity throughout its course, inasmuch as it was undergoing a slow and probably continuous structural change in the crystallisation of its individual grains. Alike in the metal and the ice, nature was apparently following one structural process, and the consequences as to plasticity were alike in both. In neither case was any constancy to be found save the constancy of change. Nothing was more striking to a worker in this field than the evidence he found that those substances on which we were most accustomed to rely as constant were undergoing, sometimes comparatively fast and sometimes very slowly, a process of internal flux. A monument more enduring than brass might be a lofty ideal, but it was seen at least to be an ideal easy of conception when one realised how far from constant the inner structure of brass and other metals was apt to be.

THE GAS SUPPLY OF THE METROPOLIS.

A committee was appointed by the Board of Trade in January last to inquire and report as to the statutory requirements relating to the illuminating power and purity of the gas supplied by the metropolitan gas companies, and as to the methods now adopted for testing. The report of this committee has now been presented, after hearing evidence from the metropolitan gas referees, from representatives of the London County Council, the Corporation of the City of London, and each of the three gas companies concerned.

The supply of gas in the metropolis being a monopoly, provision is made in the private Acts of the various companies for securing the maintenance of certain standards of purity and illuminating power. Three gas referees are appointed by the Board of Trade, with power to prescribe and certify the situation and number of testing places to be provided, and to lay down the conditions under which the testings are to be made. By the insertion of clauses in recent Acts obtained by the gas companies bearing on the mode of testing, these powers have been somewhat curtailed. The testing places are usually fitted up in houses owned or leased by the gas companies, the tests being made by officials appointed by the controlling authority, either the London County Council or the Corporation of the City of London. A comparison of the tests made at the official stations with tests made with a portable photometer in the neighbourhood of those stations having shown considerable discrepancies, attempts have been made by the controlling authority to legalise the portable photometer, but these attempts have been successfully resisted by the gas companies before Parliament, and the present committee in the report is not prepared to recommend the adoption of such tests. As, however, these results have given rise to doubt as to whether the gas supplied to the testing stations really represents the gas supplied to the public, the gas referees have laid down a requirement that the gas to be tested is to be brought direct from the main to the testing place by a single service pipe, without tap or branch or provision for connection of any kind outside the testing place. This has been strenuously resisted by one of the companies, and has led to the curious result that, although the referees have powers to prescribe testing places, they have no powers to enforce their prescription, and owing to the deadlock thus created two testing places have remained closed for some years.

The committee is of opinion that this requirement is a reasonable one, and that it might with advantage be made a statutory requirement not dependent on the prescription of the gas referees.

In the case of any deficiencies being found by the official examiners, action is taken by the controlling authority before a magistrate, with a view to the recovery of the forfeitures specified in the Acts. If any technical objection is raised by the gas companies, the question is referred to

the chief gas examiner (Lord Rayleigh), and unless the appeal is sustained the case is referred back to the magistrate for the assessment of the amount to be paid. The gas companies have always strongly objected to these police court proceedings, and the committee recommends a modification of the existing provisions whereby, in future, police court proceedings will not be required when the chief gas examiner shall certify that the default is not substantial, or that it is not due to careless conduct at the works, the forfeitures in all such cases being left for assessment to the chief gas examiner. The committee also recommends that in the case of any disputes arising between the gas referees and the gas companies, they should be referred to the chief gas examiner, and that his decision should be conclusive and binding on both parties.

Important concessions to the companies are recommended by the committee with regard to the amount of sulphur impurity allowed. In addition to a relaxation of the stringency of the tests to be applied for the detection of sulphuretted hydrogen, it is suggested that the standards for the amount of sulphur present in the gas, other than sulphuretted hydrogen, should be abolished. The committee has been influenced in this decision by the consideration of the nuisance created near the works by the use of lime purification, and the danger to the men employed in connection with the process. At the same time, however, it is proposed that the official tests should continue to be made, and that the amount of impurity in each form contained in the gas should be ascertained and recorded.

In view of the increasing amount of gas used in incandescent burners and for heating and power purposes, it is considered desirable that the calorific value of the gas should be determined and recorded, but no standards are proposed, and photometrical data with flat flame burners, in addition to those already made with the standard Argand, are also suggested as desirable.

The report has been issued within five months of the date of appointment of the committee, and it is to be hoped in the interests of the public that the legislative action necessary to carry these suggestions into effect may be made with equal promptness.

SEISMOLOGICAL NOTES.

IN the *Bollettino della Società Sismologica Italiana*, vol. ix., No. 7, Dr. A. Ricco gives an interesting paper on the relative values of gravity in the vicinity of Etna, Sicily, the Æolian Islands, and southern Italy. The results are shown in two sketch maps, on which a series of lines having the appearance of isomagnetics pass through places at which the difference between the expected and the observed values for g are equal. The smallest values for the anomaly or $g-\gamma$. are found round the summit of Etna, whilst maxima occur in the proximity of deep water about 80 km. to the south-south-west and 150 km. at Stromboli to the north. A similar but not so marked gradient is found in the vicinity of the Bay of Naples. Along the Apennines and in central Sicily the anomaly is small, and the gradient is gentle. These observations are discussed in relation to volcanic and seismic activity, orographic and geotectonic conditions. An obituary notice of Dr. Mosé Contarini, who died at the early age of twenty-eight, at the commencement of a promising career, and a catalogue of disturbances for July, 1902, complete the number.

In vol. ix., No. 8, of the same publication, Dr. A. Cancani describes and analyses five seismograms relating to earthquakes with known origins. The peculiarity of these seismograms, copies of which are given, is that they were obtained on a high speed (72 to 97 mm. per minute) smoked paper record receiving surface.

The diagrams are therefore sufficiently open to read periods of half a second, which periods refer to the preliminary tremors. From the interval in time between the commencement of these first movements and the commencement of the large waves, the distances of origins from Dr. Cancani's station in Rome are calculated. The accuracy of the results obtained therefore depend upon the accuracy with which these two phases of motion can be identified upon the seismograms. In the first earthquake considered these identifications are clear, but if the figures for the remainder are exact reproductions of the original seismograms, it seems extremely likely that very different results might be arrived at by different investigators. For writing pointers with a minimum of friction, Dr. Cancani uses the hanging aluminium indices of his colleague, Dr. Grablovitz. The cost per annum for the recording materials, which include 730 sheets of paper, gas or oil for smoking, and varnish for fixing the same, &c., is about 3*l.* 15*s.* At the end of the number the earthquake registers are brought up to the end of August, 1902.

The Austrian Earthquake Commission publish in No. 22 (new series) observations made by Dr. W. Láska in 1902 in Lemberg. They refer to records obtained from Reubeur-Ehlert horizontal pendulums.

In the *Mémoires* of the Geological Committee of St. Petersburg, No. 9 (new series), Dr. V. Weber gives a detailed account of the earthquake which on January 31, 1902, destroyed Chemaka. The epifocal area appears to lie along the major axis of a series of elliptical isoseists, and a map on which these are shown also indicates the different degrees of destruction in various villages within the disturbed district.

The phenomena observed are similar to those noted with many large earthquakes.

Another publication received from Russia is the *Bulletin* de la Commission Centrale Sismique Permanante. It refers to records obtained in the months April, May, and June at Tiflis, Taschkent, Irkutsk, Dorpat, and Krasnoiarsk, at each of which stations there are one or more seismographs.

The contributions to seismological knowledge received from Japan are as usual both varied and interesting.

Following in the footsteps of Dr. C. G. Knott, Mr. A. Imamura, in the reports of the Physico-Mathematical Society of Tokyo, vol. ii., No. 8, discusses certain earthquake registers, with the result that he finds that seismic disturbances have not only been most frequent at the times of conjunction and opposition of the sun and moon, but also at the times of quadrature. The extent to which barometrical pressure may effect seismic frequency is to be found in the same journal, the author being Dr. F. Ōmori. Another note by the same writer describes a horizontal pendulum controlled by an inverted pendulum. The former is 1 m. in height, and has a boom 1 m. in length which carries 50 kg. With its control a period of one minute is obtained without difficulty.

Dr. Ōmori's most important work is contained in No. 15 of the *Publications* of the Earthquake Investigation Committee. It relates to the measurement of the vibrations of railway carriages as recorded by seismographs. For years past the balancing of locomotives and the state of the permanent way have in Japan been determined by means of these instruments, and the practical advantages leading to the saving of fuel and the detection of faults which have accrued are generally known. Here we have an elaborate extension of previous work which railway engineers may read with advantage.

At the end of this number an index is given to the contents of the sixty-three profusely illustrated series of volumes and parts which, since 1893, have been issued by the Tokyo Earthquake Investigation Committee. Unfortunately for European readers, forty-seven of these publications are in Chinese idiographs. Amongst the latter we find reports upon seismographs, observations made in deep bore holes, notes upon magnetic disturbances which have preceded certain large earthquakes, many observations made for the purpose of determining the transit velocity of earthquake motion, observations relating to subterranean sound phenomena, observations upon sea waves, investigations relating to seismic frequency, reports upon faults, landslips and volcanoes, and a mass of material, all the result of patient investigation, which is of great importance to modern science. Many of the papers are of immediate value to those who have to construct in earthquake countries. Not only has the Japanese Government encouraged its engineers to study the effects of earthquakes upon structures within its own territory, but lengthy reports upon the damage which took place in Assam in June, 1897, indicate that it was considered advisable to derive lessons from misfortunes in foreign countries, and for this reason missions of

engineers and men of science have been sent not only to India, but to Manila, Italy, and other places. One set of instructive reports refers to destruction and shattering produced by movements closely approximating to those of actual earthquakes given to a platform on which masonry and other structures had been erected. This platform is in no sense a toy, but a large piece of apparatus actuated by powerful machinery. To say that these investigations have during the last ten years cost the Government of Japan 50,000*l*. is a modest estimate. The return for the same is seen in the new types of structures which are growing up in Japan, replicas of which have been adopted in British possessions and other places, the meaning of which is that danger to life and property resulting from seismic disturbances, if not averted, has been markedly mitigated.

Add twenty volumes issued by the Seismological Society to those published by the Investigation Committee, and we have eighty-three publications, the greater number of which are volumes, as Japan's contribution to recent seismological progress.

In consequence of not being acquainted with researches carried out in the Far East—and we do not refer to those which Japan for the benefit of her own people has published in Chinese characters—it is not uncommon to find seismologists in Europe reproducing as novelties the *faits accomplis* of past history. Had Prof. Odone read the *Transactions* of the Seismological Society of Japan, it is not likely that in a recent number of the *Bollettino* he would have given, with drawings almost identical with those published in Japan, a description of a method by which the relative motion of two points of the earth's surface might be measured; neither should we find in the last number of the same journal a description, quoted from the *Comptes rendus*, January 26, 1903, of a new system by which record receiving surfaces could be set in movement, and therefore ready to receive the record of an earthquake before the earthquake itself arrived to actuate the indices of a seismograph. In 1884 in Japan nine stations were electrically connected, so that an earth movement at one of them resulted in the release of clockwork at all the others (*Trans.* Seis. Soc., vol. x.).

Since then the system has been greatly extended, and at stations considerable distances apart record receiving surfaces are set in motion before the pointers resting on the same have been actuated by earth movements. That work of this description, which was referred to over and over again in publications issued twenty years ago in Japan, should in 1904 be reproduced in Europe as original indicates that the work has at least had some slight recognition. The main point at issue, however, is that the veil of Chinese cryptograms which has hidden so very much of the work done in the Far East has by means of an index been partly raised, and if at Strassburg or at any other institution this work can be rendered available to seismologists who read a European language, the same will from "many an error free us," and be most gratefully received.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following appointments of university lectures are announced:—Chemistry, Messrs. W. J. Sell, F.R.S., and H. J. H. Fenton, F.R.S.; organic chemistry, Mr. S. Ruhemann; petrology, Mr. A. Harker, F.R.S.; invertebrate morphology, Mr. A. E. Shipley, F.R.S.; physical anthropology, Mr. W. L. H. Duckworth; palæozoology, Mr. H. Woods.

The new Balfour student is Mr. R. C. Punnett, of Caius College. A grant of 50*l*. from the Balfour fund has been made to Mr. L. Doncaster, King's, in furtherance of his researches on sex and heredity.

Messrs. C. Shearer and W. E. Agar have been nominated to occupy the university's table at the Naples Zoological Station.

The special board for biology proposes that Mr. J. W. Clark should be re-appointed a manager of the Balfour fund for a period of ten years.

The original researches of Messrs. R. Hosking, W. Makower, G. Owen, and F. Rogers, advanced students in experimental physics, and in engineering, have been approved by the special board for physics and chemistry as of distinction; they will receive certificates qualifying them for the B.A. degree for research.

Five candidates have gained the university diploma in agriculture; seven have qualified in the first part of the examination.

Mr. H. M. Chadwick, Clare, Mr. C. H. W. Johns, Queens', Dr. A. Macalister, St. John's, and Dr. F. H. H. Guillemard, Caius, have been appointed members of the new board of anthropological studies.

Dr. D. MacAlister, St. John's, has been appointed assessor to the regius professor of physic. Prof. Darwin, Trinity, and Prof. Larmor, St. John's, have been appointed electors to the Isaac Newton studentship in astronomy and physical optics.

MR. PERCY F. KENDALL has been appointed professor of geology in the University of Leeds, and Dr. J. B. Cohen has been appointed professor of organic chemistry in the same university.

MRS. AMANDA W. REED has, says *Science*, provided in her will for the foundation of an institution at Portland, Oregon, to be known as Reed Institute, in memory of her husband, the late Simon G. Reed. The bequest will amount to about 400,000*l*. Her will specifies that the institute shall combine instruction in the fine arts, sciences, and manual training, and that it shall be conducted with especial regard to the needs of young men and women compelled to earn their own living.

NEW science buildings, which by special permission of Lord Kelvin have been called the Kelvin Science School, are to be opened by Sir Douglas Fox at Trent College, Derbyshire, on June 29. The new science school contains six large rooms and three small ones; these include a room for manual instruction in wood and iron, a physical laboratory, a lecture theatre to seat eighty, a balance room, a chemical laboratory for twenty-four students, and a biological laboratory for sixteen students.

A PAPER read by Prof. Israel C. Russell before the Research Club of the University of Michigan in January last is printed in *Science* for June 3. After referring to the triumphs of science in the last century, Prof. Russell remarked:—"The intellectual tide-gauges of the world give no suggestion that the nineteenth century wave of discovery has culminated. On the contrary, there is abundant evidence to show that the rate of intellectual development is still on the increase, and that yet more important conquests in the domain of the unknown than have illuminated the past will be made in the future." The recognition of the importance of research by the United States is naturally emphasised in the paper, and three important steps in this direction are marked by what Prof. Russell called "enduring movements," viz. the *American Journal of Science*, which appeared first in 1818, the Smithsonian Institution, and the Carnegie Institution. Speaking of the place of research in the university, Prof. Russell expressed his agreement with the dictum of Sir Norman Lockyer, that "research is now generally acknowledged to be the most powerful engine of education that we possess."

THE twenty-eighth annual exhibition of work executed in the public elementary schools founded by the late London School Board, and now administered by the London County Council, was held from June 13 to 18 at the Medical Examination Hall, Victoria Embankment. As in previous years, one section of the exhibition was devoted to the science work done in these schools. The exhibits were chiefly pieces of apparatus and working models made or arranged by pupils and teachers. It was satisfactory to notice that the work of pupils and teachers was this year kept separate, and the confusion which in some former years resulted from an indiscriminate intermingling of the exhibits of teachers and taught was fortunately avoided. Much of the work shown was the joint product of the science

departments of the schools and of the manual training centres, and the standard of excellence attained may be taken as proving that good results follow the correlation of the instruction in science and in manual work. The total number of exhibits was unusually small, and it is difficult to find a reason for the inclusion among them of scientific instruments obtained from manufacturers. The collection of exhibits, though interesting and from some points of view satisfactory, did not succeed in conveying an adequate idea of the work in science accomplished in the schools. The man of science interested in education would have obtained a better general idea of the scope of the science work in the council's day and evening schools had typical laboratory note-books and typical syllabuses of work done been exhibited. There was, however, evidence enough to show that the claims of science to a place in the curriculum of the public elementary schools of London are recognised by the London Education Committee.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 2.—"On the Magnetic Changes of Length in Annealed Rods of Cobalt and Nickel." By Shelford **Bidwell**, F.R.S.

The magnetic changes of length in annealed iron were described by the author in 1894 (*Proc.* Roy. Soc., vol. lv. p. 228). When subjected to a longitudinal field gradually increasing from a small value, an ordinary iron wire is at first extended, then it recovers its original length, and finally becomes shorter than when unmagnetised. In annealed iron the maximum extension is diminished, and contraction begins in a weaker field, the change-of-length curve being lowered. In the case of a thoroughly well annealed specimen, contraction began in a very weak field without any preliminary extension. Similar experiments have now been made with cobalt and nickel. Cobalt in the ordinary condition behaves oppositely to iron, contracting in weak fields and lengthening in strong ones. It was found that a well annealed rod of cast cobalt contracted uniformly in fields up to 1360 units (the highest reached), the retraction curve being a straight line. This confirms an observation published last year in Japan by Honda and Shimizu. For a specimen of rolled cobalt, however, the change-of-length curve retained its general form, but was considerably lowered; in a field of 1750 the ascending limb was still below the axis of H and nearly parallel to it; probably, therefore, there would never be any elongation, however strong the field. The most noteworthy effect of annealing upon the retraction curve for nickel is an increase in the abruptness of its descent, which may be due merely to greater magnetic susceptibility. Thus it appears that well annealed specimens of iron, cobalt and nickel all undergo contraction when longitudinally magnetised.

Mineralogical Society, June 7.—Dr. Hugo Müller, president, in the chair.—The Rev. Mark **Fletcher** contributed a note on mispickel from Sulitjelma Mine, Norway, containing about 1·32 per cent. of cobalt, and showing the forms {011}, {012}, {110}.—Mr. G. F. Herbert **Smith** exhibited a hand-refractometer of the Bertrand type, in which the curvature of the focal surface had been reduced by means of a correcting lens, with a consequent improvement in the definition of the shadow edges.—Prof. H. A. **Miers** gave an account, illustrated by numerous lantern slides, of the development of the Kimberley Diamond Mines. He traced the changes in the methods of working from the first surface diggings to the time when the blue-ground was brought to the edge of the pit by a "cobweb" of wire ropes stretching from the numerous independent claims into which the mines were split up, and showed how the increasing difficulties involved in this method led to the final consolidation of the mines under Beit and Rhodes, and to the initiation of the present system of mining, which consists in sinking shafts on the edge of the pit, and running cross-cuts into the blue-ground. He referred finally to the recent discovery of blue-ground in the neighbourhood of Pretoria.

Faraday Society, June 9.—Dr. J. W. Swan, president, in the chair.—The electric furnace: its origin, transformations and applications, part i.: M. Adolphe **Minet**. The paper discusses the growth of the furnace from the historical point of view, and then proposes a new classification, which is worked out in minute detail in the form of a table. A full bibliography of the electric furnace completes this section of the paper.—A form of porous diaphragm convenient for laboratory use: Dr. F. M. **Perkin**. It consists of two perforated concentric porcelain cylinders packed in between with brown paper, asbestos, or other material, depending on the use to which the diaphragm is to be put.—The hard and soft states in metals: G. T. **Beilby**. The views advanced by the author are based on his earlier observations on surface flow in crystalline solids. The evidence afforded by the micro-structure has been supplemented by observations on the other properties of metals in the hard and soft states, and the view is now advanced that these states are perfectly distinct phases. This is shown by the mechanical, electrical, optical, and thermochemical properties, as well as by the micro-structure.

Royal Meteorological Society, June 15.—Capt. D. Wilson Barker, president, in the chair.—Effects of a lightning stroke at Earl's Fee, Bowers Gifford, Essex, April 13: Rev. C. F. **Box**. A thunderstorm occurred during the early morning hours, and about 3 a.m. there was a blinding flash, lighting up the whole neighbourhood for miles around, followed immediately by a crashing explosion. One person stated that he saw what appeared to be a cylinder, and another person a ball of fire, descend and then explode, "casting darts" in all directions. On careful examination in daylight, it was found that in an oatfield, which had recently been dredged, there were three distinct sets of holes ranging from 9 inches down to about 1 inch in diameter. The holes, which were perfectly circular, diminished in size as they went downwards, and remained so on to the perfectly rounded ends at the bottom. Upon digging sectionally into the soil, which is stiff yellow clay, it was found that the holes were "as clean cut as though bored with an auger." An interesting discussion followed the reading of this paper.—An instrument for determining the true direction and velocity of the wind at sea: A. Lawrence **Rotch**.

PARIS.

Academy of Sciences, June 13.—M. Mascart in the chair.—Muscular displacement applied to carrying a load without displacement, the statical work of muscle. The comparison of this internal work with the resulting expenditure of energy, and influence of the magnitude of the load: A. **Chauveau**. Use was made of the respiratory coefficient in measuring the energy expenditure, and this was found to increase faster than the load sustained, although for small loads these were found to be nearly proportional.—The influence exercised by small variations of external actions on a system affected by hysteresis and defined by two variables: P. **Duhem**.—On the property possessed by a considerable number of bodies of projecting a ponderable emanation spontaneously and continuously: R. **Blondlot**.—A photographic study of the spectrum of the planet Jupiter: M. **Millochau**. The photographs were taken with a spectrograph attached to the large telescope of the Observatory of Meudon (84 cm. diameter), and the spectra obtained extended from the F line to the C line, means being taken to allow of a comparison of the spectra from the bands with that from the other parts of the disc. The presence of water vapour is clearly proved.—Remarks on the preceding communication: J. **Janssen**.—On a class of differential equations with multiform integrals: Pierre **Boutroux**.—Energy in statical reactions: Eugène **Lebert**. A discussion of the results of M. Chauveau on the "statical work" of muscle.—On the index of refraction of solutions: C. **Chéneveau**.—Contributions to the study of the n- and n_1-rays: Jean **Becquerel**.—On the forms of high frequency lighting between platinum wires of small diameter: André **Broca** and M. **Turchini**.—The action of the n-rays on pure water: Julien **Meyer**. Experiments are described leading to the conclusion that pure water, submitted to the action of the n-rays, becomes itself a source of n_1-rays.—On the measurement of the mobility of the ions in gases by a null method: Eugène **Bloch**. The method of MacClelland, improved by Zeleny, is modified by conversion into a null method, which much extends the field of its application.—The atomic weight of nitrogen: the analysis of nitrogen

monoxide by weight: Ph. A. **Guye** and **St. Bogdan.** The ratio of nitrogen monoxide to the oxygen it contains, determined gravimetrically, gives a value 14·007 for the atomic weight of nitrogen.—On the decomposition of a mixture of calcium carbonate and an alkaline carbonate under the action of heat in a vacuum: P. **Lebeau.** The decomposition by heat in a vacuum of mixtures of calcium carbonate and the carbonates of cæsium, rubidium, potassium, and sodium was complete. The amount of carbon dioxide obtained corresponded exactly to the amount of carbonates taken, and in all cases pure calcium oxide was left behind.—On some cuprous salts: A. **Joannis.** Details are given of the preparation of cuprous formate and benzoate.—On a basic ferric phosphite: E. **Berger.**—On the alloys of magnesium with bismuth and magnesium: Hector **Pécheux.**—Iodine compounds obtained with metanitraniline: P. **Brenans.**—On a spontaneous alteration product of oxalacetic ester: L. J. **Simon.** A sample of oxalacetic ester which has been kept for some time gives a violet colour reaction when placed in contact with an alkaline solution. This is not given by the freshly prepared substance, and is probably due to a dioxyquinone, formed by the elimination of one molecule of water between two molecules of oxalacetic ester.—Polyacid salts of rosanilines: Jules **Schmidlin.**—On the variations shown in the composition of seeds during their maturation: G. **André.**—The distribution of some organic substances in orange flowers: Eug. **Charabot** and G. **Laloue.** The petals contain the greater part of the essential oil.—On zymase and alcoholic fermentation: P. **Mazé.**—On *Mitsukurina Owstoni*: Léon **Vaillant.** This only differs from the elasmobranchs, with which it has been compared, by characters of the second order, and the author regards it as belonging to the family of Lamnidæ. This is not in accord with the views of Jordan, who regards it as a distinct type.—On a transformation of the tentacular apparatus on certain species of Madrepora: Armand **Krempf.**—Some polytaxic characters in species in the wild state: G. **Coutagne.**—Chains of force: M. **Hartog.** A description of a model reproducing certain phenomena of cell formation by the motion of magnetisable particles placed in a magnetic field in a viscous medium.—On the morphology of the root of plants with mutilated embryo: P. **Ledoux.**—The discovery of fossil-bearing layers in Djoua, to the east of Timassanine, Sahara: F. **Foureau.**—On the fauna of the Cretacean Ceratodus layers of Djoua, near Timassanine, Sahara: Émile **Haug.**—On the fauna of the Lydian of the Vosges sandstones: C. **Nöel.**—The survival of a negroid type in the modern populations of Europe: Eugène **Pittard.** The examination of skulls from the Rhone Valley, dating from the thirteenth century up to the commencement of the nineteenth century, shows evidences of a well marked negroid type, which may be a simple survival or a case of atavism.—The structure of the muscular fibres of the heart in molluscs: Pierre **Vigier.**—On the muscular fibres of the heart in *Nassa reticulata*: M. **Mader.**—The effect of the chromatism of the eye in colour vision: A. **Polack.**—A new example of physical adaptation between a natural stimulus, a sound vibration, and a central perceptive organ: Augustin **Charpentier.** By the use of phosphorescent screens a third example is given of an influence exercised directly by a natural agent upon the corresponding nervous centre.—The action of the *n*-rays upon an isolated nerve trunk: Paul L. **Mercanton** and Casimir **Radzikowski.** The sciatic nerve of the frog is not excitable by exposure to the *n*-rays.—Researches on the physiological effects of radium: C. J. **Salmonson** and G. **Dreyer.**—The relations between intra-organic combustions and the proportion of oxygen contained in the arterial blood: J. **Tissot.** Intraorganic combustions, measured by the values of the respiratory exchanges, are independent of the proportion of oxygen contained in the arterial blood.—Researches on the blood of Selachians. The toxic action of the blood of *Torpedo marmorata*: E. **Gley.**—The use of calcium sulphide against dodder and other injurious parasites: F. **Garrigou.**

NEW SOUTH WALES.

Linnean Society, April 27.—Mr. Thomas Steel in the chair.—Descriptions of new species of Australian Coleoptera, part vii.: A. M. **Lea.** Thirty species are described as new. Three previously unnoticed blind species from Tasmania are recorded—*Annomatus 12-striatus*, Müll., introduced from England, probably with pot plants; *Phycochus graniceps*, Broun, found also in New Zealand; and *P. sulcipennis*, n.sp. The number of blind species known from Australia and Tasmania is thus brought up to a total of eight.—Contributions to a knowledge of Australian Entozoa. No. iii. On some species of Holostomidæ from Australian birds: S. J. **Johnston.** Five species, all parasites of Australian birds, are described as new.—Australian fungi, new or unrecorded. Decades vii.–viii.: D. **McAlpine.** Of the twenty species recorded, seventeen, referable to thirteen genera, are described as new. Myriangium, formerly classed with the lichens, is represented by two species, and a new genus, Amphichæta, allied to Monochæta, Sacc., is proposed. The favourable condition of the specimens examined has made it possible to give a description of the spores of a species of Hexagonia—apparently the first to be recorded.

DIARY OF SOCIETIES.

FRIDAY, JUNE 24.

PHYSICAL SOCIETY, at 5.—Chemical Dissociation and Electrical Conductivity: A. E. Garrett and Dr. R. S. Willows.—The Magnetisation of Iron in Bulk: Dr. W. M. Thornton.

MONDAY, JUNE 27.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Anglo-French Boundary Commission in Nigeria: Colonel G. S. McD. Elliot, R.E.

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THURSDAY, JUNE 30, 1904.

MATHEMATICAL BOOKS.

(1) *An Introduction to the Study of Geometry.* By A. J. Pressland, M.A., F.R.S.E. Pp. 40. (London: Rivingtons, 1904.) Price 1s.

(2) *Elementary Geometry.* By Cecil Hawkins, M.A. Part i. Pp. viii+165. Part ii. Pp. 166–296. (London: Blackie and Son, Ltd., 1904.) Price 2s. each volume.

(3) *Geometry for Technical Students.* By E. H. Sprague, Assoc.M.Inst.C.E. Pp. viii+60. (London: Crosby Lockwood and Son, 1904.) Price 1s.

(4) *Graphs and Imaginaries.* By J. G. Hamilton, B.A., and F. Kettle, B.A. Pp. 42. (London: Edward Arnold, 1904.) Price 1s. 6d.

(5) *Five-figure Tables of Mathematical Functions.* By John Borthwick Dale, M.A. Pp. xvi+92. (London: Edward Arnold, 1903.) Price 3s. 6d. net.

(6) *Logarithms for Beginners.* By Charles N. Pickworth. Pp. 47. (London: Whittaker and Co., 1904.) Price 1s.

(7) *Calculating Tables.* By Dr. H. Zimmermann. Translated from the German by L. Descroiz. Pp. xxxi+204. (London: Asher and Co., 1904.) Price 6s. net.

(1) MR. Pressland adopts the heuristic method in this course of experimental geometry for beginners. The first exercises only require the use of a pencil and a graduated straight edge cut from ruled school paper. With these the boy draws triangles and quadrilaterals, bisects lines and erects perpendiculars. Symmetrical figures, such as the square, rhombus, kite, &c., are made by paper folding.

A ruler with two edges decimally subdivided into inches and centimetres is then introduced, together with two set squares and a protractor. Parallel and perpendicular lines are now readily drawn, and the work becomes quantitative, lengths, angles, and also areas being measured.

The pupil is next required to use compasses, and becomes acquainted with some properties of circles. Two or three pages are then given to proportion and graphic arithmetic. The book concludes with a set of examples in practical geometry, and a table of general properties of figures, only partially enunciated, and intended to be completed by the pupil himself from observation and discovery in the course of his experimental work.

The aim has been to train the hand and eye, to create interest, and to make the boy acquainted with the groundwork of the subject. Deductive geometry is not introduced, nor is there any attempt at a logical sequence. The author states that many features of his book are due to his experience as an inspector of schools in Canton Zürich. The course seems a good one within its limited sphere, but the experimental work might with advantage have been somewhat more extended and varied.

(2) In so far as the subject is dealt with, Mr. Hawkins's geometrical course is a very good one. It is confined to plane geometry, part i. relating to simple rectilineal figures and the circle, and part ii. dealing more particularly with areas, proportion, similar figures, and further properties of the circle. The author follows the reform movement, the propositions required for the Previous Examination under the new Cambridge syllabus being marked with an asterisk. A prominent feature of the work is the very large number of examples which are given, extending to upwards of 1500, of varied character, and affording ample choice for practice in experimental, practical, and theoretical work. The only thing lacking is a collection of the numerical answers. The examples are appended to the successive propositions, and in addition, at the end of each volume is a set of miscellaneous examples, carefully graduated, and covering the whole of the previous ground.

By omitting any reference to simple functions of angles, the author has deprived himself and his readers of a very instructive and fruitful field for examples in ratio and proportion, and of elementary calculations of right angled triangles; and the omission of solid geometry leaves the course incomplete. But the general scheme is well planned and developed, and the book cannot fail to give satisfaction to many readers.

(3) The plan of Mr. Sprague's book is based largely on experience gained by the author in the teaching of engineering students for the Chinese Government, and is intended more especially for those who take up geometry as part of their professional training as engineers.

The more important fundamental properties of plane figures, including the triangle and circle, and of simple geometrical solids are established by deductive methods, comprised in forty-eight propositions with corollaries, and accompanied by a few exercises, and the book concludes with fourteen problems in practical plane geometry.

In comparison with many recent manuals, this textbook seems to be deficient. It will not satisfy those who require a good theoretical course of elementary geometry, nor yet others who are more interested in the experimental and practical development of the subject, and the work is not likely to be generally adopted by any class of students.

(4) In graphing the parabola $y=ax^2+bx+c$, the object being to solve the quadratic equation $ax^2+bx+c=0$, the authors show that when the roots are unreal, say $\alpha\pm i\beta$, the points $\alpha\pm\beta$ lie on a second parabola. The latter is easily drawn, being the former turned into a new position, and α and β can then be measured. In like manner the coordinates of the imaginary points where an external line cuts a parabola are shown to be readily found by making use of the properties of a certain companion or "shadow" parabola.

The authors then give the "circle method" of solving a quadratic, and by means of a "shadow" circle extend the solution to the case of unreal roots. Further examples of shadow circles are given, applied to the imaginary points of intersection or contact of lines and circles. The constructions are curious and interesting, but of little or no value to young students, whose time should not be employed on them.

(5) Mr. Dale's tables have been compiled with the view of meeting the requirements of workers in physical science and applied mathematics, and exclude such functions as are of use only in navigation. They comprise tables of common and hyperbolic logarithms, of reciprocals, squares, cubes, square roots, and cube roots; natural and logarithmic functions of angles; elliptic, Bessel, gamma, exponential, and hyperbolic functions; zonal surface harmonics and some other tables.

The table of logarithms of numbers is modelled on the ordinary four-figure log tables now so largely employed. It has the same number of rows of figures, the mean differences for each row being given, and it occupies only three pages. From it the five-figure log. of any three-figure number can be read directly. For a four-figure number the tabulated difference would require to be added, and for a five-figure number an additional difference for the last figure must be added. In the early part of the table the mean differences vary so quickly as to be of no use for five-figure accuracy, and, indeed, here the fourth figure is scarcely trustworthy. In such cases the author ingeniously recommends the use of the table of anti-logs, in which at the corresponding region the differences vary slowly.

The tables of trigonometrical functions each take up four pages. Five-figure values are given for intervals of $3'$ or $0^{\circ}.05$, and the mean differences for each row are given for $1'$ and $2'$.

Probably these five-figure tables of logarithms and functions of angles are not quite so convenient in use as the more lengthy five-figure tables provided with a thumb index. But occupying as they do only about one-tenth the space, the author has been able to include in a handy volume, at a moderate cost, tables of many transcendental functions which hitherto have not been very readily accessible, and they will be welcomed by the class of people for whom they are intended.

(6) Mr. Pickworth states that the object of his little book is to give a more detailed and practical explanation of the use of logarithms than is to be found in the text-books of algebra and trigonometry. The ordinary two-page tables of four-figure logarithms and anti-logarithms of numbers are given, and the detailed explanations are accompanied by exercises for practice, the answers to which are collected at the end. There is also a short table of the logarithms of some numbers which are of frequent occurrence in numerical work.

Students who are being taught practical mathematics at the present time, and who use a suitable modern text-book, will find in the latter all the information they need on the subject, without having recourse to a book like Mr. Pickworth's. The work seems specially adapted to meet the case of those who received their mathematical training at a time when logarithms were neglected or relegated to the higher branches, and who wish to be able to use this method of computation.

(7) In the preface the author of these tables expresses the opinion that the ordinary aids to arithmetical calculation, such as slide rules, tables of logarithms, &c., are not adapted for general use. Thus he states that logarithms are only understood by very few, that they involve considerable trouble in searching the pages, and that they are seldom employed except for trigonometrical work. However true this may be of Germany, it is scarcely applicable to this country at the present time, where, thanks largely to the influence of South Kensington, logarithms are being taught to large numbers of youths in the classes for practical mathematics, and four figure log tables are in very general use throughout the kingdom.

The author's plan of meeting the common want of the computator is to supply a large multiplication table, which covers 200 pages and goes up to 100 times 1000. That is, the product of any two numbers one of which contains not more than three digits, and the other not more than two, can be taken directly from the table. Running along the bottom of the pages is a table giving, for three-figure numbers ranging from 0.1 to 99.9, the square and square root, cube and cube root, reciprocal, logarithm, and the products $\pi n/2$ and $\pi n^2/4$. On the last two pages are several useful subsidiary tables. In the introductory pages the uses of the tables are fully explained and illustrated with examples, worked out. It is shown how to deal with numbers of more than three digits, and how to perform division, square and cube root, &c. One advantage in the use of these tables is that the calculations are readily adapted to any degree of accuracy that may best suit the particular case under consideration, and contracted methods of working are explained by means of which all superfluous figures may be omitted.

The book should prove very useful for many purposes, such as in mercantile calculations, the evaluation of convergent series, the compilation of tables, &c. Every care has been taken by both author and printer to make the tables thoroughly trustworthy, and to facilitate reference. They are printed in clear bold type, and the general arrangement is very attractive.

RECENT ENTOMOLOGICAL WORKS.

Monograph of the Coccidae of the British Isles. Vol. ii. By Robert Newstead. Pp. 270; pls. F., xxxv.–lxxv. (London: Ray Society, 1903.)

The Coccidae of Ceylon. By E. Ernest Green, F.E.S. Parts i.–iii. Pp. xliii+249; pls. i.–xciii. (London: Dulau and Co., 1896, 1899, 1904.)

New Zealand Neuroptera; a Popular Introduction to the Life-histories and Habits of May-Flies, Dragon-Flies, Caddis-Flies, and Allied Insects inhabiting New Zealand, including Notes on their Relation to Angling. By G. V. Hudson, F.E.S. Pp. ix+102; with eleven coloured plates. (London: West, Newman and Co., 1904.) Price 10s. 6*d.*

ENGLISH entomologists and horticulturists are to be congratulated on the completion of Mr. Newstead's important work, which furnishes us, for the first time, with a satisfactory account of the British species of one of the most destructive families of insects, the Coccidæ or scale insects. They are peculiarly destructive to trees and greenhouse plants,

though by no means exclusively attached to them, and are consequently very liable to be carried from one country to another. But it is rather startling to read in the preface,

"The number of species found within the British Isles is eighty-eight, with four varieties; of this total, fifty-one species and two varieties have been found living under glass, and have undoubtedly been introduced from other countries. A few of these aliens have, apparently, existed in this country as plant pests for more than half a century; while others have been introduced within the last fifteen years, and with the exception of a few species, have apparently come to stay, and add to the difficulties of plant-culture."

The males are small delicate insects, and the females are apterous, and are sometimes ornamented with elegant laminated appendages of wax, as in the species of Orthezia, which are not uncommon on grass, nettles, and other low plants. It must not be forgotten that although the Coccidæ include such destructive insects as the American blight and the San José scale, other species furnish us with some of the most useful products obtained from insects, such as cochineal, lac, &c. It remains to add that Mr. Newstead has given us a very full account of the transformations, habits, &c., of each of our British species, and that the plates are excellent.

There are few more useful, and at the same time few more injurious, families of insects than the Coccidæ, and also few which have been so much neglected by entomologists until within the last ten or fifteen years, though latterly they have been so much studied by good observers in most parts of the world that our knowledge on the subject has advanced by leaps and bounds. Thus, in 1891, only seven species of Coccidæ were recorded from Ceylon, but Mr. Green took up the study immediately afterwards, and in November, 1894, he was already able to enumerate not seven, but seventy-two distinct species which he had observed up to that date. In the preface to the present work, dated September, 1896, he says:—

"This large number will be almost doubled in the present work, . . . and when other parts of the island have been properly explored, it is probable that considerably over two hundred species will be recognised."

It is needless to say that such estimates usually prove to be very much below the mark. The three parts of Mr. Green's book already published include ninety-one species, belonging to three subfamilies out of eleven (Conchaspinæ, Diaspinæ, and Lecaniinæ, of which last only the genus Lecanium is at present monographed), and nine genera, besides preface, glossary of terms, introductory and supplementary chapters on habits, classification, remedial measures, &c. We are not told how many more parts will be required to complete the work, and it is possible that Mr. Green himself cannot at present decide, for there will no doubt be large additions required to the earlier portions. He appears to have done his work very completely and thoroughly, and the illustrations are excellent. Respecting these, Mr. Green writes:—

"The lithographic plates, reproduced from my own drawings, have been most carefully printed in colours by P. W. M. Trap, of Leiden."

We are pleased to see that Mr. Hudson is continuing his efforts to make the small, but highly interesting, insect fauna of New Zealand more widely known, and we hope he will continue to deal with other orders in succession. As in other groups of animals, the Neuroptera exhibit the usual characteristics of the fauna, a very small total number of species, a striking absence of most of the characteristic Australian groups, and the presence of a very few remarkable species peculiar to New Zealand. Among the latter we may mention the handsome dragon fly *Uropetala Carovei* (named by Adam White after the author of the "Story Without an End"), which superficially resembles our British *Cordulegaster annulatus*, Latr., but is larger.

Mr. Hudson describes the early stages of many of the species he notices, and figures several larvæ and pupæ in addition to the perfect insects. In an appendix he discusses the food of trout in New Zealand, founded on an examination of the contents (chiefly insects) of sixty trout stomachs. On the other hand, the larvæ of some of the larger Neuroptera may (like those of Dytiscus among the Coleoptera) be destructive to fish. Thus we read (p. 5), "The larva of *Stenoperla prasina*, Newm., might perhaps prove destructive to very young fish."

The Mallophaga and Psocidæ are not included in the present volume, and the Embiidæ and Panorpidæ are unrepresented in New Zealand. We have thought a comparison of the number of species of the families dealt with by Mr. Hudson, found in Britain and New Zealand respectively, might be interesting:—

Families	Britain	New Zealand
Termitidæ (White Ants)	0	3
Perlidæ (Stone Flies)	24	3
Odonata (Dragon Flies)	40	10
Ephemeridæ (May Flies)	37	13
Sialidæ (Alder Flies)	2	1
Hemerobiidæ (Lace-winged Flies)	48	8
Phryganeidæ (Caddis Flies)	136	24

W. F. K.

DARWINISM AND THE STATE.

La Concurrence sociale et les Devoirs sociaux. By J. L. de Lanessan. Pp. 308. (Paris: Félix Alcan, 1904.) Price 6 francs.

M. DE LANESSAN has added yet another to the many books that undertake to show the working of Darwinian principles among civilised races, and this, like so many other books dealing with the same subject, shows no real knowledge of Darwinism. The author is strongly anti-Darwinian, and maintains that the struggle for existence leads to degeneration in the labouring class, which finds itself over-matched in the struggle against an aristocracy or a plutocracy.

At the outset some clear definition is needed. What is meant by degeneracy? Apparently our author means the under-development of the individual through defective nourishment and unhealthy conditions generally. This is, no doubt, a great evil, but it is not racial degeneracy. Would M. de Lanessan deny that the physical strength of civilised peoples is maintained by the large amount of elimination that still goes on? (In England nearly 50 per cent. of the population die before the average age of marriage,

and so approximately that percentage is from the evolutionist's point of view, of no account.) The most thorough-going Darwinian would agree that a nation is weakened by class antagonism, just as a hive of bees would suffer if the workers were divided into two factions who were always thwarting one another. The struggle for existence often takes the form of a struggle between communities, not between individuals, and it scarcely needs to be said that one which is not distracted by disunion is stronger than one which is. Disunion within is a bad thing, but opposition from without may be a blessing. The constant presence of an enemy almost at the gates was the making of ancient Rome. M. de Lanessan owns that war, more than anything else, strengthens the bond of union among citizens and fosters the growth of patriotism. Indeed, without war national feeling would not have existed. Our author, after half admitting this, speaks of a supreme phase of evolution when there will be no distinction of races.

The second part of the book is more practical and more interesting. Anti-Darwinism disappears for a while, and we hear only of the duties of the State. Since unchecked competition, whether between classes or individuals, is disastrous, the State must limit and regulate it. The State must deal with questions of public health, inspect factories, and see that workmen are not exposed to unnecessary dangers and are compensated if injured. The State should see that distress is relieved. Old age pensions should be provided even for those who are too poor to contribute towards them themselves. But saving should be encouraged in every way, though our author owns that accumulations of capital lead men to choose the wrong women as wives. The State must make every effort to prevent war between capitalists and their employés. A long chapter is devoted to the progress of the race, no distinction being drawn between evolution and progress in civilisation. Mothers and their children must be better cared for. The length of the working day must be curtailed, since this would ennoble the lives of workmen, and so improve future generations. Education must be supplied gratis by the State, and should be of a practical kind, the subjects being such as will help a boy in after life. Science, not literature, is what is wanted. Finally, morality and religion come up for discussion. The State must instil moral principles and leave religion alone. Altogether the State has a great deal of work to do.

F. W. H.

CHEMISTRY OF THE SUGARS.

Die Chemie der Zuckerarten. By Prof. E. O. von Lippmann. Dritte Auflage. Two vols. Pp. xxxiii+2003. (Brunswick: Vieweg und Sohn, 1904.) Price 30 marks.

The appearance of a new edition of Prof. von Lippmann's well known treatise is of importance to all interested in the chemistry of the sugars. To workers in this field the book has long been indispensable and in daily use. The author is to be congratulated on the care and accuracy with which he has compiled the third edition. Since the appearance of the previous edition, in 1895, the work has almost doubled in size, owing to the very large amount of investigation which has been done in connection with the carbohydrates, especially on the physiological side. Two new chapters, dealing with formation in the plant and physiological behaviour of the sugars, have been appropriately introduced. The book preserves its former arrangement: under each sugar is given its occurrence, preparation, properties, estimation and a complete glossary of its derivatives, so that reference to any particular point is very easily made. Special chapters are devoted to constitution, configuration and synthesis and to the relationship between the physical constants of the various sugars. The book is clearly printed in large type and space formulæ are liberally used. The inclusion of investigations published early this year shows how completely the account has been brought up to date and reflects the greatest credit on author and printers alike.

It is easy, with the aid of such a work, to take stock of the progress made in sugar-chemistry during the last ten years, the second edition having been published shortly after Fischer's classic syntheses of the hexose sugars. To the eleven out of the possible sixteen aldohexoses, synthesised by this chemist, no new additions have been made, though the degradation methods of Wohl and Ruff have enabled us practically to complete the series of the inferior sugars—thus there are described two aldo- and one keto-trioses, four aldo- and one keto-tetroses and seven aldo- and four keto-pentoses, only one aldo-pentose, *l*-lyxose, remaining to be synthesised. But our shortcomings are also painfully evident. Although the series of the monosaccharides is almost complete but little progress has been made either in characterising or in determining the structure of the disaccharides; and from the synthesis of cane-sugar by purely chemical means we are seemingly as far off as ever. One natural biose—melibiose—however, does appear to have been obtained synthetically and the most recent work points to the possibility of synthesising biose sugars by means of enzymes, a process which must be closely allied to that taking place in nature. It is in this direction, in fact, that we have grounds to hope for the next great advance in our knowledge.

The relationship between configuration and susceptibility to the action of enzymes or to alcoholic ferments affords one of the most striking chapters in physiological chemistry. Thus the only fermentable sugars contain six carbon atoms—neither more nor less. The statement that glycerose syrup was fermentable has since been withdrawn and we believe also that the supposed fermentability of mannononose has been recognised as incorrect. Of the eleven known aldo-hexoses only three—glucose, mannose and galactose—and but one ketose—fructose—are fermentable. Not only do these fermentable hexoses occur naturally but three of them are so closely related that they possess a common enolic form; it is all the more remarkable that the closely related aldopentoses, arabinose and xylose, which are so abundant in nature, are not fermentable.

Regarding the work as a whole, it is beyond question that not only those interested in the carbohydrates but chemists generally owe Prof. Lippmann a great debt of gratitude for his labours.

E. F. A.

OUR BOOK SHELF.

Religion and Science: Some Suggestions for the Study of the Relations Between Them. By P. N. Waggett, M.A. Pp. xii+174. (London: Longmans, Green and Co., 1904.) Price 2s. 6d. net.

It is pleasant to find in a book which seeks to deal from the religious standpoint with the relations between religion and science, a full and candid recognition of the claims of natural knowledge. The author of the present volume, whose qualities would no doubt have carried him far had he chosen the field of scientific research for the exercise of his chief activity, has not forgotten his early training. We should not expect from Father Waggett, nor do we find, the least attempt to blink or to minimise the results of scientific investigation in any department of learning. "Religion," as he says, "can have no possible interest in believing what is not true"; nor, it may be added, can religion afford to ignore what *is* true, from whatever quarter the demonstration of truth may arrive.

The book is not to be taken as a manual of apologetics—in fact many of those to whom it is primarily addressed may be inclined to complain of the author for not coming to closer quarters with the outstanding questions between religion and science. Its object is rather to state the present position, to suggest the lines on which future discussion should proceed, and to indicate the most hopeful means of arriving at a satisfactory conclusion, whether in the realm of thought or conduct. This object is carried out temperately and fairly, and with no lack of appreciation of what is strong in the scientific and philosophical position.

The author speaks, with possibly undue modesty, of his own opinions on the "domestic" issues that divide biologists. Holding, as he does, that "natural selection remains scientifically the most probable and philosophically the most welcome account of the adaptations of animal and vegetable life," he is perhaps inclined to attach too much weight to the arguments that have been brought forward by various scientific authorities on the other side. We miss any explicit reference to the views of Baldwin, Osborn and Lloyd Morgan, which have an important bearing on the whole question of adaptation, and go far towards removing some of the difficulties inherent in the rigid view of heredity. More stress might also have been laid on the quantitative aspect of variation, which is now taking definite shape in the hands of Karl Pearson and other workers. The book, however, on the whole is well abreast of modern inquiry, and may be studied with advantage by many others besides the class of readers for whom it is chiefly intended. F. A. D.

The Thompson-Yates and Johnston Laboratories Report. Vol. v. (New Series). Part ii. December, 1903. (Published for the University Press of Liverpool by Longmans, Green and Co.) Price 12s. 6d.

This new volume of the "Thompson-Yates and Johnston Laboratories Reports" opens with obituary notices of the Rev. Stephen Yates, to whose munificence the Thompson-Yates Laboratories owe their foundation, and of Prof. Nocard. The preliminary report of the trypanosoma expedition to Senegambia of the Liverpool School of Tropical Medicine occupies two-thirds of the volume, the authors being Mr. Dutton and Dr. Todd, to whom praise is due for the careful and detailed account of their journey and researches. (This has also been published as a separate report.) The laboratory methods of investigation are first described, and the results of the examination of a number of natives and of various animals for the presence of trypanosomata are then detailed. Only a small proportion of natives was found to be infected, and various experiments on the transmission and pathology of the trypanosoma are given at length. Horses were found to suffer from a fatal trypanosoma disease differing apparently in some respects from nagana. Trypanosomes were also detected in a number of birds, frogs, tortoise, mice, &c. The report is copiously illustrated, and forms an important contribution to the subject of trypanosomiasis, the appended bibliography being a very full one. Mr. Theobald adds notes on the species of mosquitoes collected in this expedition. Among these is a new species coming very near Stegomyia, for which a new genus is created, Catageiomyia. Prof. Ronald Ross contributes a brief article on a new human parasite, the Leishmann-Donovan body, which has already been referred to in these columns (Nature, vol. lxix. p. 495). Messrs. Glynn and Matthews give some interesting details of the numbers of bacteria and their variation under different conditions in swimming baths, and Dr. Stephens and Prof. Boyce detail the examination of a diseased haddock, with description of a parasite the nature of which is not clear. The general "get-up" of the volume maintains the standard of its predecessors, paper, printing, and illustrations all being excellent.

R. T. Hewlett.

L'Industrie de la Soude. By L. Guillet. Pp. 178. (Paris: Gauthier-Villars, n.d.) Price 3 francs.

This little book is a publication of the Encyclopédie Scientifique des Aide-Mémoire. It treats of the extraction of common salt, and the hydroxide and carbonates of sodium and of sodium peroxide, and within its compass it gives a fairly accurate account of the modern methods of manufacture of these articles. It is not obvious, however, for what class of readers the work is intended. It is too technical for ordinary people; indeed, most manuals of theoretical chemistry give quite as much information on these special subjects as is contained in this book. On the other hand, no technologist or person actually interested in the manufacture of these articles would rest satisfied with the extent and nature of the descriptive matter. There may, however, be persons to whom a book with a modicum of theory and a minimum of practice appeals.

Telephoto-Work. By G. H. Deller. Pp. 64. (London: Dawbarn and Ward, Ltd., 1904.) Price 1s. net.

This little book on telephoto work is one that will appeal to the numerous photographers who now keep a telephoto lens among their photographic equipment. The late author has described fully, illustrating his remarks with an excellent set of process reproductions, the many directions in which this lens may be successfully used, such as in landscape work, architecture, portraiture, and, finally, in short exposure work. Two other useful chapters, by H. Wild and H. M. Hames, deal respectively with the advantages of the "Adon" lens, and with an inexpensive means of practically learning the elements of telephotography by means of a home-made lens.

Buy English Acres. By C. F. Dowsett. Pp. 224. (Published by the Author, Winklebury, Basingstoke.) Price 3s. 6d. net.

This is not a book in the ordinary sense. It is a collection of miscellaneous arguments, extracts from books, and biographical notes, all intended to prove that pleasure and profit may be derived from the purchase of English land. The absence of any attempt at coherence or sustained economic discussion is atoned for, so far as possible, by the author's great earnestness. Apart from that, the book has no serious qualities.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Variation of Atmospheric Absorption.

REFERRING to a communication from me in NATURE of November 5, 1903 (vol. lxix. p. 5), to the effect that a definitely less amount of heat had been received at the earth's surface in the last years than in preceding ones, I would ask attention to an article published in June in the *Astrophysical Journal*, in which I have further indicated that the diminution of the heat received in 1903 may well have been due not only to an increased absorption in our own atmosphere, but in part to a real change in the solar emission, connected with a diminished transmissibility of the solar envelope.

Still more recently I have made further experiments, as yet unpublished, on changes in the transmissibility of the solar atmosphere. These experiments, made by the study of homogeneous rays from a large solar image formed by a horizontal telescope of 140 feet focus, are independent of changes in the earth's atmosphere, and have indicated that the absorption in the solar envelope has decreased within the last six months.

In agreement with this, independent computations of the total solar radiation through our own atmosphere (and so far less trustworthy than those just mentioned) tend to show that the radiation of the sun has somewhat increased during the same interval. I desire not to be understood as stating that these recent changes have undoubtedly occurred, but I feel that there is increasing probability of the confirmation of this result.

There is no novelty in the suggestion that there may be an increase or diminution of solar heat and light due to various causes, and since my earliest statement of the absorption of the solar atmosphere, in the *Comptes rendus* of the Paris Academy of Sciences for March 22, March 29, and September 6, 1875, the subject has, in fact, engaged my continued attention.

What I wish to remark now is that it is only in comparatively recent years that the gradual perfection of the bolometer and other apparatus is providing specific data which render it likely that such changes are now coming within our means of direct recognition.

In sum, the result of the most recent spectrobolometric observations is an increasing probability that the solar radiation itself varies in a degree appreciable to our present means of daily observation, and a strengthening of the belief I have elsewhere expressed that it probably varied through much larger ranges in the past, and may do so again in the future

It will be seen that I do not venture yet to assert without restriction conclusions like these, which, so far as they may be shown to be true, are not merely of abstract interest, but which in a utilitarian sense may be said to be of far-reaching concern; yet I think it time to ask more general attention to them. S. P. LANGLEY.

Smithsonian Astrophysical Observatory, June 20.

Use of Radium in Section Cutting.

EVERYONE who has to cut microtome-sections of material embedded in paraffin-wax is frequently troubled by the electrification of the sections. The electrification causes the sections to adhere to the microtome-knife and to fold on themselves instead of being pushed easily across the blade of the knife so as to form a smooth ribbon. The adhesion to the knife also renders the transference to the microslip difficult, and often leads to the breaking up of sections and consequent loss of continuity in the seriation. Further, even when successfully detached from the knife, the electrified sections are apt to fly about in such an erratic way that it is often a matter of difficulty to arrange them in an orderly manner on the slip.

These undesirable phenomena may be completely avoided by fixing a 5 mg. tube of radium bromide on the microtome-knife close to where the paraffin ribbon is forming. Apparently the radiations from the radium discharge the electrification of the paraffin sections by ionising the air in their neighbourhood. HENRY H. DIXON.

Botanical Laboratory, Trinity College, Dublin.

The Blondlot *n*-Rays.

THERE is reason to think that M. Blondlot has rendered very valuable service to science by directing the attention of physicists to the remarkable, if not altogether mysterious, class of phenomena with which he has recently had to deal.

There can be no doubt that the phenomena, strange as they may seem to be, which he and his colleagues have observed, whether appearances or realities, or, should I say, subjective or objective effects, still leave something that remains unexplained. Psycho-physiological phenomena are not the less interesting because they happen not to be *physical effects* as ordinarily understood, and if they can lead scores of trained physicists astray, they should be regarded as all the more important.

For one, I am unhappy in that I cannot merely not see the effects, but neither have I been fortunate enough to meet with anybody who, on severe cross-examination in the dark, did not satisfy me that the variations in brightness which he had observed were altogether subjective, and the result of imagination or fatigue, for expectation counts for a great deal in these observations, and concentration of attention for still more.

The one thing that seemed conclusive about these rays was that they produced so great an increase in the brightness of a small spark that the effect could be photographed, and M. Blondlot has himself shown us photographs which it would appear show unmistakably this result.

I have followed in his footsteps as closely as I could, but unfortunately have not obtained any difference in the photographic effects which could not be attributed to a spurious cause. In M. Blondlot's experiment there is no proof that the diminished brightness of the spark, when a lead screen is interposed, is not due to the presence of the metallic screen itself, which is so close to the spark that it would damp the oscillations of the spark and affect its photographic effect. I have preferred to put out the source of *n*-rays altogether, and to wait for some time, ten minutes or so, or to place a lead screen at a considerable distance from the spark.

I have used a spark of about 1/10th mm. between two brass spheres, each of about 1 cm. radius. The effect on a photographic plate 2 cm. away is that of a luminous band the edges of which are close to the spark, practically straight lines, and at a greater distance curve round, being branches of two hyperbolæ.

A change in the brightness of the spark is accompanied by a broadening of the band, and a change in the intensity of the diffuseness of the plate. The breadth of the band depends upon the exposure, and conversely upon the brightness of the spark. Except when there were errors in the adjustment of the apparatus, the two photographs taken on the same plate indicated the same brightness.

It is interesting to note in connection with this point that M. Jean Becquerel maintains that the alleged change in brightness of a phosphorescent screen is really due to an effect on the retina due to the *n*-rays which are reflected by the luminous body. This explanation, however, will not fit in with M. Blondlot's photographic effects, as these rays are not supposed to produce any direct photographic effects. But M. Becquerel's conclusion confirms my result that the *n*-rays, if there be any such, do not really intensify the brightness of a luminous body, even if this be the property by which they were supposed to have been discovered. JOHN BUTLER BURKE.

Cavendish Laboratory, June 21.

ABORIGINAL AMERICAN BASKETRY.[1]

THE attention of our readers has several times been directed to papers and memoirs by American students on aboriginal American basketry; some authors, like L. Farrand ("Basketry Designs of the Salish Indians," *Mem.* Am. Mus. Nat. Hist., ii., 5), G. T. Emmons ("The Basketry of the Tlingit," *l.c.* iii., 2), R. B. Dixon ("Basketry Designs of the Maidu Indians of California," *Am. Anthrop.*, June, 1900; "Basketry Designs of the Indians of Northern California," *Bull.* Am. Mus. Nat. Hist., xvii.), and a few others have studied the designs plaited in baskets, and have discovered their symbolism. W. H. Holmes ("A Study of the Textile Art in its Relation to the Development of Form and Ornament," Sixth Ann. Rept. Bureau Ethnol.) was one of the first to direct attention to the effect of the technique on the ornamentation of baskets, while the technique itself of basketry has persistently been studied by Dr. Otis T. Mason, and now he has increased the indebtedness of ethnologists to his labours by the publication of a monograph which gives a much needed general survey of aboriginal basketry in America.

As is usual in publications coming from the United States, this work is lavishly illustrated, there being 212 figures in the text and 248 beautiful plates, several of which are coloured. The memoir deals with basket

FIG. 1.—Pomo Basket-maker.

making (including a valuable section by F. V. Coville on the plants used in basketry), ornamentation and symbolism, uses of basketry, and ethnic varieties of baskets. The last section is the most valuable, as it enables us for the first time to make a comprehensive survey of this beautiful industry as practised by the aborigines of North America, for, despite its title, the basketry of Mexico and of Central and South America is only cursorily dealt with in this monograph.

Owing to differences of climate, rainfall, and other characteristics of environment, the materials for

FIG. 2.—Modified Forms on Basketry.

basketry vary greatly from region to region throughout America, and this in spite of all ethnic considerations. Again, the motives for the use of basketry differ from place to place, so much so that peoples of one blood make one ware in this place and another in that. Finally, however, writes Dr. Mason, it must never be forgotten that the ideas, utilitarian and artistic, in the minds of the manufacturers themselves, serve to bestow special marks upon the work of different tribes, so as to give to them ethnic or national significance in any circumstances. Were there no mixture of tribes it might be possible to state in every case the maker of each specimen from the technique and the ornamentation; but throughout the entire continent the practice of capturing women was common, and in each case the stolen ones carried to their homes the processes they had been familiar with in their native tribe, and, further, the materials for basketry were traded, as were probably the baskets themselves. New designs are occasionally introduced along with ancient patterns, as may be seen in Fig. 2, where dogs and horses are interspersed among pre-Columbian decoration; indeed, the influence of the white man is very rapidly modifying native American basketry; "in methods, forms and colours truly old things have passed away, and, behold, all things have become new." A. C. H.

[1] "Aboriginal American Basketry: Studies in a Textile Art without Machinery." By Otis Tufton Mason. Report of the Smithsonian Institution, 1902, U.S. National Museum (1904).

THE MINING STATISTICS OF THE WORLD.

ONE of the recommendations of a Departmental Committee of 1894 was that the British mining industry should be compared with similar industries of other countries, and from that time Sir Clement Le Neve Foster compiled annually for the Home Office an invaluable collection of comparative mineral statistics. Every year the report showed improvement, and every year the difficulties arising from want of adequate official statistics were more nearly obviated. While the present report was in preparation Sir

Clement Le Neve Foster died, and it has therefore not had the advantage of his exceptional technical knowledge, literary skill, and critical acumen in its final revision. His loss to the Home Office is a serious one, and it will be difficult to find an editor with his wide acquaintance with foreign mining literature to fill his place.

The information given in the report deals with the number of persons employed, the quantity and value of minerals produced, and the loss of life from accidents in mines and quarries throughout the world. The statistics given in this concise, intelligible and inexpensive form are of the greatest importance from a commercial point of view. In the United Kingdom alone the value of the minerals produced in 1902, the year under review, was 107,104,884*l*., and the vast sums representing British capital invested in mines in all parts of the world will be readily appreciated. Some indication of the growth of the mining industry during recent years is indicated by the following comparison of the world's output of metals in 1889 and in 1902:—

	1889 Metric tons	1902 Metric tons
Iron	26,000,000	42,669,000
Gold	182	447
Silver	3,900	4,753
Copper	266,000	572,000
Lead	549,000	803,000
Zinc	335,000	503,000
Tin	55,000	93,000

In 1902 the world produced 803,157,000 tons of coal, 22,869,000 tons of petroleum, and 13,279,000 tons of salt. Of the coal supply, 34 per cent. was furnished by the United States, 29.5 per cent. by the United Kingdom, and 19.4 per cent. by Germany. Although the United States outstripped Great Britain in production, the value of the British product was 93,521,000*l*., whilst that of the American was 75,373,000*l*.

As gold producers, the British possessions take the first place, furnishing more than half the world's supply. Australia supplied 24 per cent., the Transvaal 12 per cent., and Canada 7 per cent. of the total. The United States contributed 27 per cent. The value of the total production exceeds 60,000,000*l*. Nearly one-fourth of the world's salt and three-fifths of the tin are produced by the British Empire. On the other hand, the production of copper, lead, petroleum, silver, and zinc is small in comparison with the world's output. Of copper, the United States, with the enormous output of 299,000 tons, produce more than half the copper of the world, and Spain and Portugal together about one-tenth. The United States also produce most lead, 30 per cent. of the world's total, Spain and Germany following. Russia and the United States are the two great petroleum producers. In the British Empire, Canada and Burma are the only oil regions, and their production is comparatively small. Of silver, the United States again are the largest producers, followed closely by Mexico. The German Empire, with its rich Silesian mines, is the leading zinc-producing country, furnishing one-third of the world's supply. The United States take second place in the list. Of other valuable minerals raised in 1902, diamonds to the value of 4,950,000*l*. were produced in Cape Colony. Italy has no equal for its sulphur (value 1,706,000*l*.), Chili for its nitrate of soda (value 9,500,000*l*.), Germany for its potassium salts (value 2,000,000*l*.), Spain for its mercury (value 173,000*l*.), and the United States for their phosphates (value 1,000,000*l*.).

Any strictly accurate comparison between the number of persons employed in the mining industries of the various countries is impossible. The figures collected are, however, sufficient to give a general idea of the relative importance of mining in each country. The total number of persons engaged in mining and quarrying throughout the world may be taken at 4,500,000, of whom one-fifth are employed in the United Kingdom and one-third in the British Empire. More than half the total number were employed in mining coal, Great Britain employing 750,000, the United States and Germany each 500,000, France 165,000, Belgium 135,000, Austria 123,000, and India 100,000.

The accident statistics are not so complete as might be wished. For coal mines, the figures show that the death rate from accidents in mines and quarries per 1000 persons employed is 1.24 in the United Kingdom, 1.46 in the British Empire, 1.09 in France, 1.93 in Germany, and 3.25 in the United States. The death rate for foreign countries generally is 2.20. It is evident that mining is conducted in Great Britain with a far smaller risk of accident to the workers than in most other countries.

The first part of the general report on mines and quarries for 1903 has also been issued. It contains statistics of the number of persons employed, the output of minerals, and the number of accidents in the United Kingdom. The British production in 1903 included 230,334,469 tons of coal, 16,198,021 tons of clays and shale, and 13,715,645 tons of iron ore.

B. H. B.

NOTES.

IN the long list of birthday honours published on Friday last, we notice that Mr. Charles Booth, F.R.S., has been made a Privy Councillor; and that the honour of knighthood has been conferred upon Prof. J. Dewar, F.R.S., and Dr. T. Stevenson, scientific analyst to the Home Office. The Colonial Office list includes the name of Prof. W. Baldwin Spencer, F.R.S., who has been appointed a Companion of the Order of Saint Michael and Saint George (C.M.G.).

H.R.H. PRINCESS HENRY OF BATTENBERG will privately inaugurate the annual exhibition of the Beni Hasan excavations committee at the rooms of the Society of Antiquaries in Burlington House. The exhibits include the antiquities discovered at Beni Hasan and Negada by Mr. John Garstang, reader in Egyptian archæology in the University of Liverpool, and paintings by Mr. Harold Jones, artist to the expedition. The exhibition will be open from July 8–23 inclusive.

THE French Society of Civil Engineers has this year awarded its prizes as follows:—the annual prize to M. J. Bernard for his work on the installation in the Red Sea of three lighthouses in circumstances of especial difficulty. The Michel Alcan prize was awarded to M. L. Guillet for his researches on the composition of steel, and the F. Coignet prize went to M. V. Picou for his work on the regulation of dynamos. A prize was awarded to Prof. E. Hospitalier for his works on the study of phenomena which by their rapidity and frequency baffle ordinary methods of analysis.

H.R.H. THE PRINCE OF WALES has consented to become patron of the Royal Meteorological Society.

THE twenty-second congress of the Sanitary Institute will be held in Glasgow from July 25–30, under the presidency of Lord Blythswood. Sir Richard Douglas Powell, Bart., K.C.V.O., will deliver the lecture to the congress on "The Prevention of Consumption." It appears from the programme that 250 authorities, including several county

councils and county boroughs, have already appointed delegates to the congress, and as there are more than 3300 members and associates in the institute, there will probably be a large attendance in addition to the local members. In connection with the congress, a health exhibition of apparatus and appliances relating to health and domestic use will be held as practical illustration of the application and carrying out of the principles and methods discussed at the meetings. Popular lectures will be given in the exhibition on physical development, by Dr. P. Boobbyer; care of eyesight, by Dr. James Kerr; care of the teeth, by Mr. G. Cunningham; feeding and digestion, by Prof. A. Bostock Hill; and healthy houses, by Prof. H. R. Kenwood. The sections and their presidents are:—(1) Sanitary science and preventive medicine, Prof. J. Glaister; (2) engineering and architecture, Prof. H. Robinson; (3) physics, chemistry, and biology, Prof. Frank Clowes. There will be eight special conferences, the subjects and presidents of which will be as follows:—Municipal representatives, Mr. W. F. Anderson; industrial hygiene, Mr. J. Steele; medical officers of health, Sir C. A. Cameron, C.B.; engineers and surveyors to county and other sanitary authorities, Mr. W. Weaver; veterinary inspectors, Prof. James McCall; sanitary inspectors, Mr. T. F. Strutt; women on hygiene, the Duchess of Montrose; the hygiene of school life, Prof. John Edgar.

The death is announced of Lieut.-General Dubrovin, who was for a long time secretary of the Imperial Academy of Sciences at St. Petersburg.

Prof. W. Kaufmann, of Bonn, has been awarded the Von Baumgartner prize of the Vienna Academy.

Prof. van 't Hoff has been appointed honorary director of the medical faculty of Utrecht, and the newly erected chemical laboratory there has been named the Van 't Hoff Laboratory in his honour.

The Imperial Academy of Sciences of Vienna announces the following grants:—To the Vienna Society for Solar Observation, 1600 krone for observations on climatic changes in the Goldberg glacier, and to Prof. Ritter Beck von Managetta (Prague) 600 krone for studies of plant distribution in the Julian Alps. From the Wedl bequest, to Drs. Obermayer and Pick (Vienna) 600 krone for the chemistry of immune substances, to Dr. Moritz Probst 800 krone for continuation of work on the brain, to Dr. Karl Camillo Schneider 400 krone for a zoological expedition to Grado, to Prof. Julius Tandler 1000 krone for studies in the development of birds. The committee of the Treitel legacy awards the following grants:—To Prof. Hans Skraup (Graz) 1500 krone for studies on albumens, to Dr. Franz Werner 6000 krone for a zoological expedition to the Egyptian Soudan, to Prof. Julius Wiesner 4000 krone for effects of light on plant life in the Yellowstone district, to the Austrian Meteorological Society 4000 krone for investigations of the upper atmosphere, and to the Earthquake Commission 5465 krone 39 heller.

That the depopulation of rural districts is a social problem of the times in France no less than in this country is evident from the report presented by Dr. A. F. Plicque to the *Bulletin de la Société d'Encouragement* for April. The author makes a special study of the conditions prevailing in the canton of Donnemarie-en-Montois (Seine et Marne). This canton is situated in the midst of a fertile agricultural district possessing an excellent climate, and within moderate distance of Paris, and from 1869 to 1891 there was a falling off in the population of from 9764 to 7683 inhabitants. It is also noteworthy that an inquiry in 1893 in the same district showed that 63 per cent. of the farm labour was imported from outside, and that without this imported labour agriculture in this fertile region would come to a standstill. The author traces the causes of the depopulation to ignorance of sanitary precautions leading to a high rate of infant mortality, emigration of young people to towns, effects of conscription, alcoholism, &c., and he considers the remedy to consist in improvements in primary and technical education, which should, in his opinion, "not merely give the child verbal forms, devoid of ideas, which he cannot understand, but should give children of rural communities an instruction suited to the surroundings in which they ought to live, and should develop, from their earliest years, a taste for agriculture." M. Plicque instances the success of this method in Belgium. In other words, the successful and contented ploughboy should not be encouraged to leave his plough in order to become an unsuccessful and discontented teacher.

Would life be possible if the nitrogen of the atmosphere were replaced by hydrogen? This is a question discussed by Regnault and Reiset, who gave an affirmative answer in their well known treatise on respiration. A fresh investigation of the question is now given by Dr. Arturo Marcacci in the Lombardy *Rendiconti*, xxxvii., 9, whose experiments were conducted at Palermo. The author found that animals introduced into such an atmosphere soon died, the symptoms all indicating that the death was due to cold, caused by the high thermal conductivity of the hydrogen. Another phenomenon was the marked increase in the absorption of oxygen and evolution of carbonic anhydride.

In 1902 the *Zeitschrift fur Krystallographie und Mineralogie*, founded by Prof. P. Groth, completed the twenty-fifth year of its publication. Many mineralogists in various countries felt the occasion provided a fitting opportunity to commemorate the services rendered to mineralogy and crystallography by Prof. Groth by initiating and editing that journal. Profs. M. H. N. Story-Maskelyne, W. J. Lewis, H. A. Miers, and Mr. L. Fletcher formed themselves into a committee, and in response to an appeal a sufficient sum of money was obtained to secure the services of Prof. E. Grützner, of Munich, to paint a portrait of Prof. Groth. The picture was formally presented to Prof. Groth on April 30 last, and was accompanied by a letter from Prof. Story-Maskelyne expressing the appreciation of Prof. Groth's work on the part of the subscribers. A photogravure of the portrait, executed by Dr. E. Albert and Co., of Munich, and a statement of receipts and expenses, will be forwarded shortly to each subscriber to the testimonial.

A new scheme for a North Polar expedition was described by M. Charles Bénard at a meeting of about fifty men of science held in the house of the Prince of Monaco, in Paris, on June 19. According to the Paris correspondent of the *Times*, M. Bénard explained at length why the only feasible and rational route of penetration of the Polar Sea was one a little north of that followed by the *Fram*. The expedition ought to start from a Norwegian port, cross the southern portion of Barents Sea, take in dogs at Karabora, coast along Yalmal, ship its coal at Port Dickson, transported thither by special steamer, pass at the end of the summer along the Peninsula of Taimyr, arrive by the end of the autumn at the islands of New Siberia, and then, instead of going northward, as did the *Fram*, manage at all costs, even if it be necessary to winter in the Liakhoff or Bennett Islands, to reach a point on the 150th degree of east longitude. Thence the ship or ships need only drift with the

ice. M. Bénard urges the utility of having the expedition composed of two vessels in touch with each other by means of wireless telegraphy. The expedition should take three years, but be provisioned for five. It would not cost more than 1,500,000 francs (60,000*l*.). The assembled company signed a memorandum declaring this expedition to be of scientific utility.

At a recent meeting of the Royal Photographic Society, Mr. Conrad Beck described the unofocal (or unifocal) photographic objective which has been worked out by Dr. Steinheil, of Munich. The principle of the new construction consists in the employment of positive and negative lenses all of which have the same focal length and the same mean index of refraction, thus overcoming the difficulty of satisfying the "Petzval condition." A positive focus is obtained by separating the positive and negative elements. An example with a maximum aperture of $f/4 \cdot 5$ appears at first sight like a symmetrical triplet consisting of three single lenses, with the central negative lens divided to allow space for the diaphragm. But the inner faces of the two negative lenses are concave to each other. In the series with an aperture of $f/6$, there is a greater space between the negative elements, each of which is much nearer to the outer positive component that it is more immediately associated with. Mr. Beck stated that even the $f/4 \cdot 5$ lens gives telescopic central definition, perfect freedom from distortion and flare, and a flat field of 60° well corrected for astigmatism. An incidental advantage of the construction is that it gives a more even illumination, as oblique beams are transmitted more fully than when the elements of the combinations are in contact.

The Paris correspondent of the *Times* states that M. Henri de la Vaulx is now completing his preparations for a third Mediterranean cruise in a specially constructed balloon, some particulars of which were given at Monday's sitting of the Academy of Sciences. M. de la Vaulx will employ a 20-horse power engine of the automobile type, attached to the car, which will work an aluminium screw seven metres in diameter.

A correspondent informs us that the optical illusion mentioned in Nature of June 2 (p. 107) is described in the *Proceedings* of the Royal Society of Edinburgh (vol. x., 1878–9). In the experiments described in that paper circular rotating discs, and also travelling bands of paper, were used for exciting the eye, and it is shown that whatever the nature of the motion impressed on the eye, the surface afterwards looked at appears to move in the opposite direction. If a rapidly flowing stream, for instance, be looked at steadily for a time, and the eye afterwards directed to the bank, part of the bank will seem to flow through the middle of the field of view. The image of the part of the bank that falls on the part of the retina affected by the image of the moving water seems to flow slowly in a direction contrary to that of the stream, causing that part of the solid earth to appear as if it had become plastic.

We have received from M. A. Lancaster the *Annuaire Météorologique* of the Royal Observatory of Belgium for 1904. For sixty-eight years the observatory published annals devoted to astronomy and meteorology combined, but since 1901 each science has been dealt with separately. The work consists of some 660 pages, and, in addition to monthly and seasonal meteorological data for various places, contains some valuable papers by M. Lancaster and others connected with the service, including the motions of cirrus clouds, and the dispersion of hail clouds, by M. Vanderlinden. The latter subject is still a controversial matter, and although the results hitherto attained by shooting and other methods are not generally considered satisfactory, the experiments are likely to be continued for some years.

The *Transactions* of the South African Philosophical Society (vol. xv., part i.) contain an important paper by Mr. J. R. Sutton on South African rainfall, being the fifth of a valuable series of studies on meteorological subjects which have appeared in the same publication. The tables exhibit the daily and monthly rainfall at Kimberley recorded by Mr. F. W. Matthews between 1877 and 1902, together with the diurnal variation and other useful details; also the monthly and annual rainfall at a large number of selected stations. The values relating to Kimberley have been discussed statistically and by the process of harmonic analysis. The yearly falls from Mr. Matthews's series vary from 9·34 inches in 1878 to 31·30 inches in 1891. The greatest average annual fall occurs at Maclear's Beacon, on Table Mountain (86·81 inches), and the least at Port Nolloth (2·46 inches). Speaking of the Kimberley values, Mr. Sutton states that March is the wettest and July the driest month, the increase or decrease from one to the other being gradual. Referring to South African rainfall generally, outside the Cape Peninsula and west coast, the author concludes that rainfall decreases on the whole with distance from the coast, and that it occurs with a high barometric pressure at Durban and a low pressure at Kimberley; it comes chiefly with south-westerly winds at the former station and with north-easterly winds at the latter. The principal barometric disturbances come from the south.

A small brochure, in which Mr. G. M. Woodrow treats of the cultivation and varieties of the mango, "the choicest fruit of Hindustan," has been published by Mr. Alexander Gardner, of Paisley, and can be obtained from the office of the *Gardener's Chronicle* and certain agents in India.

In the matter of floral variation, several of the violets offer an attractive field of study, and a paper by Mr. C. E. Britton dealing with floral variations among Surrey violets will be found in the *Journal of Botany* (May). The most important aberrations occur in the corolla, where, in the case of *Viola hirta*, all stages, from the normal single-spurred petal to the symmetrical condition of five-spurred petals, were observed. The condition of regular symmetry in the case of *Viola Riviniana* appears to be produced by the suppression of the spur, but the petals are all slightly pouched at the base.

The principal historical events and appointments connected with the Royal Botanic Gardens, Ceylon, are summarised by Mr. J. C. Willis in No. 10, vol. ii., of the *Agricultural Journal*. The expansion of the gardens has not only included the formation of five branch institutions situated in different climatic regions of the island, but during the term of office of the present director the scientific staff has been increased by the appointment of several specialists. Although the introduction and investigation of plants of economic value have been carried out in Ceylon since the institution of the gardens in 1860, there has been a gradual change in the scope of the work, and systematic collection and identification have given place to physiological research and experimental cultivation.

The skull of the dinosaur *Triceratops serratus* is described by Dr. R. S. Lull (*Bull. Amer. Mus. Nat. Hist.*, xix.). A figure of the palatal aspect shows the extreme length to be about 6 feet 4 inches.

In the *Ottawa Naturalist* for May, Mr. L. M. Lambe describes the phalanges of the manus of *Ornithomimus altus*, which evidently had long and sharp claws. He considers that this dinosaur was capable of rapid motion in pursuit of prey, and had the power of tenaciously grasping with its fore limbs.

To vol. xv., part ii., of the *Proceedings* of the Royal Physical Society of Edinburgh, Mr. N. Annandale communicates the first instalment of a series of papers on the zoology of the Færöes, dealing in this instance with the land and fresh-water molluscs, isopods, and insects, each group being treated by a specialist.

From the Field Columbian Museum we have received publications of the geological series, vol. ii. In No. 3 Dr. S. W. Williston gives a detailed description of the skeleton of the American pterosaur *Nyctosaurus gracilis*, which was formerly regarded as Pteranodon, and in No. 4 Mr. E. S. Riggs gives a description and restoration of the dinosaur Apatosaurus (formerly Brontosaurus). Mr. Riggs remarks that there is a striking similarity between his figure and the original restoration of the genus by Marsh. Later on Marsh, evidently dissatisfied with its proportions, inserted additional vertebræ and ribs, and otherwise modified the skeleton, almost to the extent now rectified by the evidence since acquired.

The whole of the seven articles in the first part of vol. vi. of the *Bulletin* of the College of Agriculture at Tokyo University are from the pen of Prof. C. Sasaki, all but one dealing with insects of commercial value, more especially silk-producing moths. Special interest attaches to the description, illustrated with two coloured plates of the adult insect and larva, of native methods of rearing the fine Yamamai moth (*Antheroea yamamai*). Five of the other papers treat of various races of silkworms and different modes of feeding them, while the sixth is devoted to the life-history of the wax-producing coccid *Ericerus pela*. In the eighth and last paper the author describes a new field-mouse, under the name of *Arvicola hatenedzumi*, which appears to be the Japanese representative of *A.* (or *Microtus*) *subterraneus*.

A number of experiments have been carried out by Konradi on the duration of life of pathogenic bacteria in water (*Centr. f. Bakt.*, xxxvi., No. 2, p. 203). These show that the anthrax bacillus, the *Micrococcus pyogenes aureus*, and the typhoid bacillus may ultimately displace the ordinary bacterial forms of water and survive for a long period, anthrax for 3½ years, the *M. aureus* for as long as 545 days, and the typhoid bacillus for more than 500 days, their pathogenic properties still being retained.

Prof. Lingard raises the question whether the *Piroplasma bigeminum*, the parasite of Texas fever of cattle, can find a habitat in the human subject (*Centr. f. Bakt.*, xxxvi., No. 2, p. 214). He describes a case in which a native cattle attendant staying near bovines, the subjects of Texas fever, developed an illness partly malarial, but partly, perhaps, due to infection with the Piroplasma, the special symptoms being continued remittent fever unaffected by quinine, hæmoglobinuria, and the presence in the blood of parasites similar to the Piroplasma.

Prof. Grindley and Mr. Mojonnier, of the United States Department of Agriculture, have published the results of experiments on the losses occurring during the cooking of meat (*Bulletin* No. 141). The chief loss in weight during the boiling, sautéing, and panbroiling (cooking in frying pan without fat) of meats is due to removal of water. In the roasting of meats, the loss is due to both water and fat. When beef is cooked in water, 3·25–12·67 per cent. of nitrogenous matter, 0·6–37·4 per cent. of fat, and 20·0–67·4 per cent. of mineral matter of the uncooked meat are found in the broth. In roast meat the loss is much less, 0·25–4·5 per cent. of the nitrogenous matter, 4·5–57·5 per cent. of the fat, and 2·47–27·2 per cent. of the mineral matter being found in the dripping. As a rule, the larger the piece of meat cooked by boiling or roasting, the smaller is the relative loss. Panbroiling seems to be the mode of cooking that occasions the least loss. A statement which will cause surprise to some is that beef which has been used for the preparation of beef-tea or broth has lost comparatively little in nutritive value, though much of the flavouring material has been removed.

The Geological Survey in Ireland has just issued a memoir on the geology of the country around Belfast, with a specially prepared one-inch map of the district colour-printed to show the various drift deposits and solid strata where these appear at the surface. On the margin of the map are engraved and coloured two longitudinal sections to explain the general structure of the country—a useful feature, which serves to render this excellent map more intelligible to the uninitiated. The memoir and map are the work of Messrs. G. W. Lamplugh, J. R. Kilroe, A. McHenry, H. J. Seymour, W. B. Wright, and H. B. Muff. The description of the older rocks, from the Ordovician (or Lower Silurian) series to the Tertiary basalts, is based largely on the previous work of the Survey, supplemented by the information published by private workers. The drifts, on which the field-staff was specially engaged, are very fully described, and in the explanation of their mode of origin reasons are given for rejecting the marine theory and for adopting the land-ice theory. There is much, however, of practical as well as of scientific interest in this volume; agricultural geology is especially dealt with, and there are notes on water supply, house sites, building materials, &c., records of deep borings, petrographical notes on the igneous rocks, and a bibliography.

It may be said that the Austrian Empire covers a wide field; but its manifold activity in matters of geological research is none the less remarkable. Among recent memoirs received by us are two by Dr. W. Teisseyre on the north-eastern foreland of the Karpathians (*Verhandlungen der k.k. geol. Reichsanstalt*, 1903, pp. 289–308, and *Beiträge zur Paläontologie und Geologie Österreich-Ungarns*, Bd. xv., 1903, pp. 101–126). In these the author traces the influence of older movements, and of the resulting crust-blocks, on the present structure of the Podolian lands, and seeks to reconstruct the country as it was, firstly, at the time of the Cenomanian marine transgression, and, secondly, at the opening of the Miocene period. In so doing, he is led to regard an anticlinal mass in Podolia, upheaved in Upper Jurassic times, as a somewhat belated offshoot of the Triassic folds of the Sudetic. Dr. Tietze's report on the work done by the Geologische Reichsanstalt in 1903 (*Verhandlungen*, 1904, pp. 1–44) describes the distribution of the field-surveyors, and the visits undertaken to other lands. Among the papers issued under his energetic guidance in 1903, we note F. Kerner's description of the "Fenster," or pseudo-inliers, of the Mosor Planina, where little patches of Eocene Flysch appear in the floor of hollows excavated naturally through Cretaceous limestone. Other evidence is forthcoming to show that the latter series has been thrust over the former. W. Hammer

(*Verhandl.*, 1903, p. 345) contributes a valuable paper on pegmatites in the Ortler Alps, in which he opposes the still popular view that such veins have been formed by lateral segregation from the surrounding rocks. Dr. Romberg (p. 365) adds yet another paper to the discussion of the inter-relations of the Monzoni rocks, in which he tilts vigorously against Dr. Doelter and his associated champions.

A TENTH edition of Mr. A. Jamieson's "Elementary Manual on Steam and the Steam Engine" has been published by Messrs. Charles Griffin and Co., Ltd.

MARCONI's Wireless Telegraph Company, Ltd., has published a catalogue dealing with Röntgen ray and high-frequency apparatus, instruments and accessories. The pamphlet, which is well illustrated, contains numerous useful hints as to the use of induction coils and the charging of batteries. Particulars as to the cost of instruments described are conveniently arranged, and the catalogue should be of service to workers in these branches of science.

WE have received a copy of the *Bulletin* for November, 1903, published by the Permanent International Council for the Exploration of the Sea, the contents of the first part of which were described in the issue of NATURE for June 9, p. 139. The present *Bulletin* is divided into four parts, dealing respectively with the following subjects:—the condition of the atmosphere and of the surface water; the temperature and salinity at various depths expressed in metres; the nitrogen, oxygen, and carbonic acid dissolved in sea-water; plankton tables for Finland, Sweden, Denmark, Germany, Holland, Belgium, England, Scotland, and Russia. Attached to the several parts are numerous charts showing the results arrived at by observers of different countries. The *Bulletin* may be procured from MM. Andr. Fred. Høst et Fils, of Copenhagen.

THE April number of the *American Journal of Psychology* contains a paper by Mr. C. Spearman entitled "'General Intelligence' Objectively Determined and Measured." By means of statistical methods of considerable refinement and elaboration, the writer claims to have proved that an absolute correspondence exists between the degree of general intelligence and general power of sensory discrimination, and that there is a variable correspondence between the latter and the more complicated intellectual activities of practical life. He believes in an underlying universal unity of the intellectual function, the psychical nature of which is to be discussed in a later paper.

THE second part of the first volume of the *British Journal of Psychology* was issued on June 10. It contains four papers and the proceedings of the Psychological Society. Dr. C. S. Myers writes on the taste-names of primitive peoples, and refers to the results of a few experiments he made with Dr. Seligmann in the islands of the Torres Straits. He found that the literal meaning of the phrase commonly used in the Torres Straits to denote sweetness is "tasting good"; that the same phrase is applicable to denote saltness, the usual word for which is derived from sea-water; the taste-names for salt and sour tend to be confused; and there is no specific name for the bitter taste. Precisely similar features are found when the taste-names of Indo-Germanic languages are examined. Dr. Myers extends his inquiry to other primitive peoples, and the results are given in his paper. Mr. W. H. Winch has a paper on immediate memory in school children. Prof. R. Latta contributes notes on a case of successful operation for congenital cataract in an adult, and Prof. W. McDougall deals with the variation of the intensity of visual sensation with the duration of the stimulus.

A VERY readable paper on radium, by Mr. E. P. Poulton, is contained in the March issue of the *Transactions* of the Oxford University Junior Scientific Club.

WE have received *Communications* No. 87 and No. 88 from the physical laboratory of the University of Leyden. In the first of these Dr. Kamerlingh Onnes describes the methyl chloride circulation used in the cryogenic laboratory, and in the second the results of the determination of the isothermals of mixtures of oxygen and carbon dioxide by Dr. W. H. Keesom are given.

IT is well known that the extension of the theory of the asymmetric carbon atom by Wislicenus to account for the isomeric relationships of ethylene derivatives is in many cases unable to explain observed experimental facts. In the current number of the *Zeitschrift für physikalische Chemie*, vol. xlviii. p. 40, Dr. Pfeiffer shows how it is possible to account for many of these observations by a modification of the van 't Hoff-Wislicenus theory. With this modification the formation of the *cis-* or *trans*-isomer can be predicted, whether the ethylene compound is obtained from an ethane or an acetylene compound.

THE Carnegie Institute of Washington has just issued a pamphlet (No. 7) containing an account of a new method for determining compressibility by Messrs. T. W. Richards and W. N. Stull. Bromine, iodine, carbon tetrachloride, chloroform, bromoform, water, and mercury have been examined. In the case of a substance like bromine, the liquid is hermetically enclosed in a very thin, flexible glass bulb, and subjected to compression under mercury, correction being made for the change in volume of the mercury and the glass. A new form of high pressure manometer is described the working of which depends upon the difference between the compressibility of water and mercury.

IN a recent experimental investigation by Dr. T. Wulf, published in the *Zeitschrift für physikalische Chemie* (vol. xlviii. p. 87), it is shown that the electromotive force at which hydrogen ions are liberated from solution, when determined galvanometrically, is quite independent of the pressure when this is varied between 0·01 and 800 atmospheres. On the other hand, the polarisation of the hydrogen electrode increases with the pressure, and this increase is in quantitative agreement with Helmholtz's formula. The experiments show very clearly that the passage of a current through the solution is not necessarily accompanied by the liberation of the gas in the form of bubbles.

THE question as to whether the so-called colloidal or pseudo-solutions are essentially different in character from ordinary solutions has been the subject of much discussion and experimental investigation of late years. By applying the optical method of Tyndall to solutions, Messrs. Lobry de Bruyn and Wolff, in the *Recueil des Travaux chimiques de Pays-Bas*, vol. xxiii. p. 218, arrive at the conclusion that there is no sharp line of demarcation between ordinary solutions and pseudo-solutions. Solutions of bodies of high molecular weight, such as tristearine and the hexabenzoyl derivatives of mannite and dulcite in methyl alcohol, chloroform and acetic ether, exhibit optical properties of the same nature as colloidal solutions. Light is reflected laterally from a beam incident on the solution, and this reflected light is polarised.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY:—

July 2. 11h. 7m. Minimum of Algol (β Persei).
6. 13h. Conjunction of Jupiter and Moon. Jupiter 1° 49′ N.
9. 13h. 24m. to 13h. 44m. Moon occults 71 Tauri (mag. 4·6).
,, 14h. 5m. to 14h. 58m. Moon occults θ^1 Tauri (mag. 3·9).
,, 14h. 12m. to 15h. 0m. Moon occults θ^2 Tauri (mag. 3·6)
,, 17h. 31m. to 18h. 24m. Moon occults α Tauri (mag. 1·1).
11. 11h. 34m. to 13h. 28m. Transit of Jupiter's Sat. III. (Ganymede).
15. Venus. Illuminated portion of disc = 0·999, of Mars = 0·995.
18. 15h. 41m. Transit (ingress) of Jupiter's Sat. III. (Ganymede).
25. 9h. 38m. Minimum of Algol (β Persei).
27. Ceres stationary 3½° S. of α Scorpii (Antares).
28. Saturn. Major axis outer ring = 43″·33. Minor axis = 10″·87.
28–30. Epoch of Aquarid meteoric shower (Radiant 339° − 11°).

SMITHSONIAN INSTITUTION 1900 ECLIPSE RESULTS.—No. 1439 of the *Publications* of the Smithsonian Institution is devoted to a splendidly illustrated account of the equipment and work of the expedition sent out by the Astrophysical Observatory, under the superintendence of Prof. Langley, to observe the total solar eclipse of May, 1900.

In chapter i. the director, who was aided throughout by Mr. C. G. Abbot, gives a concise account of the objects of, and the preparations for, the expedition. Chapter ii. describes the establishment of the eclipse camp at Wadesboro, North Carolina, on the same field as the Yerkes expedition under Prof. Hale.

The loan of a 12-inch lens of 135 feet focal length by Prof. Pickering made the photography of the inner corona one of the most important objects. In summarising the results in chapter iii., Prof. Langley notes, among other things, that large prominences were observed, and appeared to be associated with regions of coronal disturbance. Bolometric observations of the inner corona showed that the heating power of its radiations was unexpectedly small. The search for an intramercurial planet was made with a camera of 3 inches aperture and 11 feet focus, and several suspicious images appeared on the plate, but as there was no confirmatory second photograph the results were inconclusive. Prof. Langley recommends a similar instrument for future observers.

The twenty-two beautiful plates which accompany the report display photographs of the observers and their instruments as erected, the corona, and parts of the inner corona.

THE ORBIT OF THE COMPANION TO SIRIUS.—From a discussion of numerous observations of its position angle and distance, Herr O. Lohse, of Potsdam, has determined the following elements (for 1900·0) for the orbit of the small companion to Sirius:—

T = 1894·337 (1844·956)	☊ = 44°·12
U = 50·381	i = 39°·91
n = −7°·14559	∞ = 212°·20
e = 0·598	a = 7″·427

A comparison of the observed places with those calculated from the elements, for various dates since 1862, shows that the elements are fairly correct, the mean error in position angle being generally less than 1°, and in distance less than 0″·2.

An ephemeris, for the years 1900–1912 inclusive, calculated from these elements, gives the position angle at the commencement of the present year as 116°·2, and the distance as 6″·6. Observations made at Yerkes on October 19 and 26, 1903, gave 115°·97, 6″·31, and 115°·06, 6″·33, as the respective position angles and distances for those dates (*Astronomische Nachrichten*, No. 3955).

OBSERVATIONS OF JUPITER DURING 1903.—The results of numerous observations of Jupiter which were made at Juvisy during 1903 are published and discussed by MM. Flammarion and Benoit in the *Bulletin de la Société astronomique de France* for June. From these observations, which agree with those of other observers, it appears that the northern equatorial band progressively diminished during 1903, appearing to condense towards the southern edge. The southern equatorial band appeared to be the centre of great activity, the great red spot forming a marked depression in the band, although not so sharply defined as in past years.

Several large bright spots appeared in the southern tropical zone, two of which, situated in longitudes 180° and 225° respectively, were remarkable. In the southern temperate zone several small white spots were observed which seemed to detach from the southern temperate band a quantity of the material of which the latter is composed. Summarising the observed phenomena, it is obvious that the southern hemisphere of Jupiter is in an active state of disturbance, whilst the northern hemisphere is remarkably quiescent.

OBSERVATIONS OF THE SATELLITES OF SATURN.—In the *Bulletin de la Société astronomique de France* for June, M. Lucien Rudaux publishes the results of a series of observations of five of Saturn's satellites made by him during the years 1892–7 and 1901–3 at his observatory at Donville (Manche).

His particular object was to record the changes in the brightness of each satellite, and from his numerous observations he concludes (1) that the satellites have periods of rotation equal to their respective periods of revolution; (2) that they (especially Japetus) have dark spots, probably permanent configurations, which cause a decrease in the satellite's apparent magnitude when presented to us; (3) consequently the apparent magnitude of each satellite varies periodically with the satellite's position in its orbit. These conclusions are certainly justified by the observations of Titan and Japetus, but in the case of Rhea the result is as yet uncertain.

THE GERMAN ROYAL NAVAL OBSERVATORY.—A quarto volume published by the German Naval Observatory under the general title "Aus dem Archiv der deutschen Seewarte" (twenty-sixth annual publication, 1903) contains papers on the following subjects:—(1) On the calculation of lunar distances by the aid of the Mercator functions; (2) estimation of the latitude of Heidelberg Observatory and its variations; (3) the daily variation of the magnetic declination; (4) the wind variation on the German coast; (5) on the "going" of the standard clocks of the German Naval Observatory; (6) the definitive elements of comet 1887 II. (Brooks). In the last named paper Prof. Dr. C. Stechert has reduced a large number of observations collected from various observatories, and has therefrom calculated the following definitive elements and the probable errors for the orbit of Brooks's comet (1887 II.):—

T = 1887 March 17·427594 ± 0·0061984 (M.T. Berlin)

$$\left.\begin{aligned} \omega &= 159°\ 26'\ 15''{\cdot}00 \pm 14''{\cdot}91 \\ ☊ &= 279°\ 56'\ 12''{\cdot}62 \pm \ 3''{\cdot}54 \\ i &= 104°\ 16'\ 10''{\cdot}47 \pm \ 3''{\cdot}18 \end{aligned}\right\} \text{Mean equinox } 1887{\cdot}0$$

log q = 0·2122261 ± 0·0000095
e = 0·9836922 ± 0·0002550.

Dr. Stechert's paper is also published in No. 3957 of the *Astronomische Nachrichten*.

AN INTERESTING METEOR TRAIL.—A peculiar meteoric phenomenon was observed by Senor J. A. Perez at Madrid on October 16, 1903. The meteor first appeared in Perseus at about 10 p.m., and the luminous trail did not entirely fade away until nearly 12 p.m. In the meantime its shape varied considerably. Commencing as an almost closed curve with a loop in it, the loop gradually developed until finally the primary curved trail almost entirely disappeared, leaving only a short faint portion entirely separated from the enlarged loop. Six drawings and a description of the phenomenon are published in No. 16 of *Das Weltall*.

THE ROYAL SOCIETY CONVERSAZIONE.

THE second of the two conversaziones held annually at the Royal Society took place on Wednesday, June 22. Many of the exhibits of recent scientific methods and results on view during the evening were shown at the conversazione held in May, and have already been described (May 19, p. 68), but there were, in addition to these, a number of new objects and experiments, of which a list is here given.

Spontaneous electrification of radium: Hon. R. J. Strutt. A specimen of radium salt in a glass tube is hung up by an

insulating support in an exhausted vessel. An electroscope is attached to the radium tube. Negatively electrified particles are shot off by the radium, and penetrate the glass tube, which is covered with a conducting coating of phosphoric acid, so as to act as an inductor. Thus a positive charge is left, and causes divergence. When the electroscope leaf touches the outer vessel, which is earthed, it collapses, and begins to charge up again. This will go on so long as the radium lasts.—Demonstration of oscillating electric discharges: Prof. A. Schuster, F.R.S., and Dr. G. Hemsalech. The separation of the components of a slowly oscillating electric discharge is effected by blowing a steady current of air through it. The discharge passes between two slightly inclined metal plates, and spectroscopic analysis shows the line spectrum of air in the initial discharge and the band spectrum of nitrogen in the oscillations. The metallic vapour from the electrodes does not seem to take part in the oscillations. The effect of introducing cores of iron or other metals into a coil giving self-induction may be illustrated by this arrangement.—The thermo-galvanometer: Mr. W. Duddell. The instrument is intended for the measurement of very small rapidly varying currents such as telephonic currents and the currents produced in the receiving vertical wire in wireless telegraphy. The sensibility of the instrument is such that either direct or alternating currents from a few micro-amperes upwards can be measured.—A new magnetic balance: Mr. W. Hibbert. The beam of a balance is made of a magnetised steel rod 27 centimetres long. The "centres" of the poles are 25 centimetres apart. The repellent pole of a second magnet being placed over one end of the beam causes this to descend, and the force of repulsion is balanced by a weight sliding on the other half of the beam.

Photographs and diagrams illustrating solar and meteorological changes, and a series of photographs to determine the relative temperatures of the stars: Sir J. Norman Lockyer, K.C.B., F.R.S. This exhibit included (1) enlarged pictures of the sun in "K" light taken with the spectroheliograph of the Solar Physics Observatory. (2) Diagrams illustrating the results of a discussion of sun-spot distribution; the relationship between the positions of solar prominences and the different forms of the corona; the different types, and their distribution, of the short-period barometric pressure variation over the earth's surface; and the close connection between the change of barometric pressure and rainfall. (3) Series of photographs taken with a quartz-calcite prismatic camera of 2-inch aperture and 18-inch focal length to determine the relative temperatures of stars. (4) Composite positives on glass of the sun's limb and disc, taken on the same plate with "K" light.—Photographs and drawings prepared from observations taken by the lightning research committee to illustrate the behaviour of lightning on certain buildings struck and damaged, notwithstanding their being provided with lightning conductors: Mr. Killingworth Hedges.—The physiotype: Mr. Francis Sheridan. This is a method of permanent printing without the use of inks, specially adapted to finger printing and the reproduction of designs from animal and vegetable life. The subject to be reproduced is pressed on paper, and by dusting the invisible impression with a coloured powder a dark and permanent print is produced.—Experiment showing the effect of internal stresses in glass upon light of different colours: Dr. L. N. G. Filon.—Photographic camera with free-swinging lens, and photographs taken with it: Dr. W. M. Flinders Petrie, F.R.S.—(1) Photomicrographs of interior of a rifle barrel; (2) photomicrographs of brass used for cartridge cases: Dr. W. R. Hodgkinson and Captain Hardcastle, R.A.

A new automatic vacuum pump: Mr. C. E. S. Phillips. The apparatus consists of a modified Toepler pump, so arranged that it works automatically through the operation of electrically controlled devices, for the purpose of producing extremely high rarefactions. The pump will reduce the gas pressure within a vessel of 200 c.c. capacity from that of the atmosphere to 0·002 mm. in fifteen minutes.—Vibrograph for recording vibrations photographically: the Cambridge Scientific Instrument Company, Ltd. The instrument is essentially similar to that used by Mr. A. Mallock, F.R.S., for recording vibrations caused by traffic on the Central London Railway.—An experiment illustrating harmonic undertones: Mr. H. Knapman.

The origin and growth of ripple mark: Mrs. Hertha Ayrton. The experiments shown illustrated the way in which the sand ripples are formed on the sea shore. If sand be spread quite evenly on the bottom of a trough, and water above the sand be oscillated so as to produce stationary waves, a small ridge is formed where the horizontal velocity of the water is greatest, next a ridge is started on each side of the first, which grows; then two more ridges are started, the former growing, and so on until the whole surface of the sand is ripple-marked. Each ripple now slowly moves towards the place of greatest horizontal velocity, while fresh ripples form near the places of least horizontal velocity. Pairs of ripples then coalesce here and there, and finally the greater part of the sand is assembled in a ripple-marked heap at the places of greatest horizontal velocity, this final result being attained, for example, in about twenty-five minutes in the case of the six-foot trough exhibited, when the stationary wave is twice the length of the trough. It was also shown that ripples are *not* produced by a *steady* current of water flowing over sand, but that by disturbing this steady current sand ripples may be formed, which, however, are erased on the current becoming steady again.

Crystalline glazes on pottery: Mr. William Burton and Mr. Joseph Burton. The specimens illustrated the decorative application to English earthenware and stoneware of certain recently discovered glazes which develop artificial crystalline silicates during the firing and cooling of the wares. In the "sunstone" and "fiery" crystalline glazes the crystals have the optical properties of micas, though their exact composition is at present undetermined. In the starry and opalescent glazes the radiating needles are akin to the mineral willemite, as is shown both by their optical properties and their composition.—Photographs of volcanic phenomena in the Lipari Islands: Dr. Tempest Anderson. The photographs, which were taken by the exhibitor in April of this year, show, besides the topography of the craters, several changes which have taken place in and about them since a former visit in 1888, and also some explosions from the crater of Stromboli which took place while Dr. Anderson was on that mountain.

Mimetic resemblance of the different forms of a single species of butterfly to two or three different models. Seasonal phases of South African butterflies of the genus Precis: Prof. E. B. Poulton, F.R.S. The fact that the non-mimetic male of the South and East African *Papilio dardanus* possesses three different forms of female, each mimetic of a different species of Danaine butterfly, was discovered by Mr. Roland Trimen, F.R.S. Within the last few months this discovery has for the first time been confirmed by breeding. The exhibited specimens, constituting the entire evidence thus obtained, were bred by Mr. George F. Leigh at Durban, Natal. The evidence of the wonderful seasonal changes in South African butterflies obtained by Mr. Guy A. K. Marshall has been further increased during the present year. His recently obtained evidence was exhibited, and consisted of a wet-season female of *Precis antilope* with its five dry-season offspring.—Colour photographs (Sanger-Shepherd process) of living moths and butterflies in their various stages of larva, pupa and imago: Mr. F. Enock.—(1) Living specimens of young flatfish; (2) methods of determining the age of plaice; (3) charts illustrating the natural history of the plaice in the North Sea; (4) charts illustrating the plankton and hydrography of the English Channel during 1903: the Marine Biological Association.—The cilioscribe, a machine to record the movements of cilia and the effect of physical conditions and chemical reagents upon them: Dr. W. E. Dixon and Mr. O. Inchley.—Specimens of West Indian fire-flies: the Zoological Society of London.

Photography of the movements of plants by means of the kammatograph: Mrs. D. H. Scott. The photographs are taken at intervals varying according to the rapidity of the movements of the plants during several days, and sometimes weeks. They are then shown on the screen in the kammatograph, and the movements of many days can be followed in a few seconds.—Models to illustrate the reduction (heterotype) divisions in animals and plants: Prof. J. B. Farmer, F.R.S., and Mr. J. E. S. Moore.

(1) Model of the external door of the Great Pyramid; (2) ellipsograph: Mr. R. Inwards.

SOME ANCIENT MAMMAL PORTRAITS.

Very little attention appears to have been hitherto devoted to the correct identification of the wild animals represented in the ancient Assyrian and Babylonian sculptures, and in the frescoes of Egypt under the Pharaohs. Antiquarians and Egyptologists seem in the main to have contented themselves with calling an animal a gazelle, an antelope, or a deer, without the slightest attempt to ascertain whether such titles are correctly bestowed, and in some cases utterly oblivious of the fact that deer (with the exception of the Barbary red deer and the fallow-deer in Tunisia, Algeria, and Morocco) are quite unknown in the African continent. A remarkable instance of this occurs in a comparatively recent publication of the Egypt Exploration Fund, forming the eighth memoir of the Archæological Survey of Egypt, entitled "The Mastaba of Ptahhetep . . . at Saggareh. Part i. The Chapel of Ptahhetep and the Hieroglyphs," by N. de G. Davies. Here a plate depicting a number of antelopes and goats is lettered "The Deer—East Wall." A moment's consultation with a naturalist friend would, of course, have saved the author from this absurd error.

Many of the animals represented in the sculptures and frescoes are obviously mythical; but others equally clearly represent species then living in the country, and these are for the most part so well and characteristically represented, that in many cases there is little or no difficulty in identifying the species to which they belong. Apart from the intrinsic interest of identifying the various species portrayed, a certain amount of information may at the same time be obtained with regard to the former distribution of the species in question, so that the investigation of the subject has considerable scientific interest.

Fig. 1.—Nubian ibex, from the Ptahhetep Chapel.

With these few preliminary observations, I proceed at once to the consideration of such figures as I have been able to identify with more or less certainty, merely adding that these for the most part represent ungulates, the portraits of Carnivora being far more difficult to assign to their respective species.

Commencing with the above mentioned figures from the east wall of the Chapel of Ptahhetep, for copies of which I am indebted to Mr. F. Ll. Griffith, the editor of the publication cited, there is no difficulty in identifying Fig. 1 with the Arabian, or Nubian, ibex (*Capra nubiana*). Although the knotted ridges on their front surfaces are not shown, the circular sweep of the horns is unmistakable, while further evidence for the specific identification is afforded by the long and pointed beard on the chin. It is, however, somewhat remarkable that in another representation of the same animal, from a hunting-scene on the east wall of this chapel, the beard is omitted; possibly one figure represents the animal in the summer dress, and the other in the winter coat. The shortness of the tail in both figures may be cited as a further instance of the artist's fidelity to nature.

Equally unmistakable and characteristic is the portrait of the aoul, or Soemmerring's gazelle (*Gazella soemmerringi*), which is reproduced in Fig. 2. The characteristic inward curvature of the tips of the horns is remarkably well shown, although the relative length of these appendages appears to be somewhat exaggerated. Contrasted with the figure of the ibex, the gazelle-like slenderness and length of limb, as well as the lightness of the whole build, are remarkably well brought out in this portrait. The short tail is also a characteristic gazelle feature. Soemmerring's gazelle, it may be observed, is still fairly abundant in Upper Nubia, and in past times may have been found much lower down the Nile delta.

The next three figures from the Ptahhetep Chapel represent long-tailed antelopes. Of these, the one shown in Fig. 3 is, I take it, probably the lesser kudu (*Strepsiceros imberbis*), if not this, the Abyssinian bushbuck (*Tragelaphus scriptus*); the length and strong twist of the horns render it, however, probable that the picture is intended for the former animal. The absence of a tuft of hair on the throat, as well as the relative size of the drawing and the narrowness of the ears, clearly show that the portrait is not intended for the greater, or true, kudu. Neither the lesser kudu nor the bushbuck are now known from Egypt, although they occur in Somaliland, Abyssinia, and probably Kordofan. The abundant hairing of the lower part of the tail is clearly indicated in the figure.

Fig. 2.—Soemmerring's gazelle, from the Ptahhetep Chapel.

From the spiral twist and length of the backwardly sweeping horns, the stout build, and the length of the tail, there can be little doubt that the animal portrayed in Fig. 4 is an addax (*Addax nasomaculatus*), a species of antelope met with at the present day throughout the desert tracts of northern Africa. The artist, it will be noticed, has made the profile of the face markedly concave, and thereby different from that of any of the other antelopes depicted.

Equally characteristic of the north African desert zone is the white, or sabre-horned, oryx (*Oryx leucoryx*), which differs from the other members of its tribe by the long horns sweeping backwards in a bold and graceful curve, instead of rising nearly straight up from the forehead. These features, as well as the long and thickly haired tail, are clearly represented in the portrait reproduced in Fig. 5, which may unhesitatingly be admitted to indicate the species in question. The white oryx is still a comparatively common antelope in the deserts of Upper Nubia and Kordofan. From the nearly straight and more strongly ringed horns, a figure of another antelope in the hunting-scene on the east wall of the Ptahhetep Chapel is intended, I think, for the beisa oryx (*Oryx beisa*), which ranges from the Red Sea littoral in the neighbourhood of Suakim through Abyssinia to Somaliland and north-east Africa generally.

Antelopes of other kinds, including some of the smaller gazelles, are recognisable on various Egyptian frescoes, but their exact specific determination is difficult or impossible. Cattle are frequently depicted, but all appear to be domesticated animals, none of which belong to the humped breed, now so common in Africa. Camels are occasionally represented, but there is nothing to show that these indicate the existence of this animal in a wild state in the country at that date; most probably, indeed, they are domesticated specimens. Very interesting, in a scene representing tribute-bearers from Cush (Goss's "Ancient Egypt," p. 37), is the portrait of a giraffe with a dog-faced baboon clinging to its throat. Curiously enough, the giraffe is

Fig. 3.—Lesser kudu (?) from the Ptahhetep Chapel.

represented with the legs spotted right down to the hoofs, after the fashion of the southern races of this species, and unlike the Nubian form, in which the spotting stops short at the knees and hocks. It must be acknowledged, however, that the artistic merit and attention to details are nothing like so good in the Cush tribute scene as in the Ptahhetep frescoes.

FIG. 4.—Male addax, from the Ptahhetep Chapel.

Among the Carnivora, the lion and the leopard are frequently depicted, but in the aforesaid frescoes of the tribute-bearers from Cush, the spots of the latter animal are represented as more like those of the ocelot. As might have been expected, the ichneumon, or Egyptian mungoose (*Herpestes ichneumon*), the snake-destroying propensities of which render it so venerated among the inhabitants of the Nile delta, is very frequently represented in the frescoes. It is well shown in Fig. 6, *A*., from the Ptahhetep hunting-scene. The fore part of the animal shown at *D* in the same figure seems to be intended for the little African fennec fox (*Canis famelicus*), the projecting appendix seen below the eye in the figure being apparently a conventional mode of representing the bristles or "whiskers," which are remarkably well developed in that species.

The long-tailed and long-hind-legged animal shown at *B* in Fig. 6 is apparently the lesser, or hairy-footed, jerboa (*Jaculus hirtipes*), the small size of the ears showing that it is not intended for the larger jerboa (*Jaculus aegyptiacus*). Another rodent shown in some of the frescoes, as in one of labourers bringing in sheaves of corn (Goss, *op. cit.* p. 195), is the Egyptian hare. The length of the ears, by which the animals are being carried, is, however, greatly exaggerated, the length of these appendages being nearly equal to that of the head and body.

A remarkable instance of fidelity to nature occurs in the two portraits of a hedgehog shown at *C* in Fig. 6, from the Ptahhetep hunting-scene, one of these representing the animal standing in the open, and the second showing it coming out of a hole with a locust in its mouth. The well developed ears clearly show that the species depicted is the long-eared hedgehog (*Erinaceus auritus*), which differs from its European cousin by the large size of the ears.

FIG. 5.—White oryx, from the Ptahhetep Chapel.

Turning to certain sculptures from Assyria, Babylonia and other parts of western Asia, I may in the first place direct attention to an illustration in Vaux's "Nineveh and Persepolis," entitled "Figure Carrying Gazelle," which is reproduced in the accompanying cut (Fig. 7). The original slab, which is preserved in the British Museum, was one of those obtained from the palace at Nimroud by Sir Henry Layard, in whose own work it bears the above-mentioned legend. Clearly such a title does manifest injustice to the genius and fidelity to nature of the ancient sculptor, who has faithfully portrayed the palmated and branching antlers and dappled hide of a fallow-deer, spots being, it is almost unnecessary to mention, quite unknown in any species of gazelle. The interest of this sculpture does not, however, by any means end here, for the details of the antlers and other features are sufficient to show that the species portrayed is evidently the Mesopotamian fallow-deer (*Cervus mesopotamicus*), which is a native of the Luristan province of Mesopotamian Persia, and was first definitely made known to European science by the late Sir Victor Brooke in 1875. That a species should have been thus clearly portrayed centuries and centuries ago by a sculptor of the

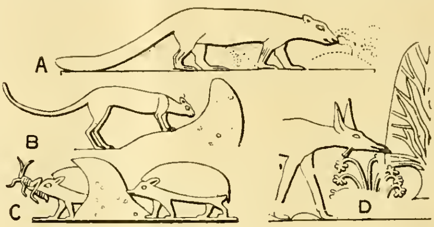


FIG 6.—Small mammals from the Ptahhetep Chapel. A, Ichneumon; B, Lesser jerboa; C, Hedgehog: D, Fennec.

Babylonian era, and should have remained unknown in western Europe until the close of the third quarter of the nineteenth century, is certainly a curious feature in the progress of human knowledge.

Of minor interest is another slab from Nimroud of which a cut appears in Vaux's above-mentioned volume, where it is lettered "Figure Carrying a Goat." The form of the horns, the general contour of the animal, and, above all, the absence of a beard on the chin, indicate, however, that the sculptor has represented one of the gazelles, which is probably the common Dorcas gazelle (*Gazella dorcas*), which at the present day has a wide distribution in North Africa, whence it extends into Palestine and Syria. It is, however, possible that the figure may be intended for the goitred gazelle (*Gazella subgutturosa*), which ranges from the Caucasus through Persia and Syria, and thence into Central Asia, where it is represented by a distinct local race.

FIG. 7.—Human figure carrying Mesopotamian fallow deer, from the Palace at Nimroud.

The last, but by no means the least interesting, sculpture to which I shall allude is one from Nimroud of which a woodcut appears on p. 225 of the work above cited, where it is described as a "Bull-hunt." The horns of the animals depicted are, however, as shown in the accompanying reproduction of the cut (Fig. 8), quite unlike those of the bulls represented in the Egyptian frescoes, and strongly recall those of the white-tailed gnu (*Connochaetes gnu*) of South Africa. Moreover, the tails of these animals are of the same type as those of the horses shown in this and other sculptures, and are quite different from those of the oxen of the sculptures and frescoes, which have a somewhat club-shaped form. It would appear, therefore, that the portrait is that of an animal with a fully haired tail

like a gnu or horse, and not one with a terminally tufted tail of the ox type. Again, the general form of the animal is much more like that of a gnu than of a bull.

Accordingly, there appears a very strong presumption that this sculpture represents the hunting of a species of gnu, and if this be really the case, it would be a fact of very considerable interest in connection with animal distribution. The two living species of gnu are now confined to Africa, but their near relatives, the hartebeests, range into Syria, while fossil species of that group, as well as of other antelopes of an African type, occur in the Upper Tertiary strata of northern India and China. Nothing is therefore more likely than that gnus should have formerly

Bull Hunt.

FIG. 3.—A gnu (?) hunt, from Nimroud.

had a more extensive range. If this be so, it would be one more argument in favour of the old view that the present antelope fauna of Ethiopian Africa immigrated into the country from the north, and against the modern theory of its autochthonous origin in Africa itself. For it is surely much more probable that animals should have died out in their ancient habitat and flourished in the country in which there are comparatively new arrivals rather than the converse.

A more extensive and detailed study of the old Assyrian and Babylonian sculptures and of the Egyptian frescoes would doubtless lead to the identification of species of animals other than those mentioned above; but such identifications as I have been able to make are sufficient to demonstrate that the subject has a definite bearing on the past distributional history of mammals, and that it ought not to be neglected by students of that branch of zoology.

R. LYDEKKER.

THE ACTION OF RADIUM EMANATIONS ON DIAMOND.[1]

WHEN diamonds are exposed to the impact of radiant matter in a high vacuum they phosphoresce of different hues, and assume a dark colour, becoming almost black when the bombardment is long continued (*Phil. Trans.*, 1879, part ii., p. 658, par. 625).

Some diamonds blacken in the course of a few minutes, while others require an hour or more to discolour.[2] This blackening is only superficial, and although no ordinary means of cleaning will remove the discoloration, it goes at once when the stone is polished with diamond powder. The fact that the black stain is not affected by ordinary oxidising reagents would seem to show that it is not due to a layer of amorphous carbon; but it might be graphite, which is much more resistant to oxidation. Becquerel has shown that graphite is converted into graphitic oxide by long digestion in a warm mixture of potassium chlorate and strong nitric acid, while diamond—even in a very finely powdered state—is absolutely unaffected by the mixture (*Ann. de Chim. et de Phys.*, [4], vol. xix. p. 392).

Some forms of graphite dissolve in strong nitric acid; others require a mixture of highly concentrated nitric and potassium chlorate to dissolve them, and even with this intense oxidising agent some graphites resist longer than others. M. Moissan has shown that the power of resistance to nitric acid and potassium chlorate is in proportion to the temperature at which the graphite has been formed, and with reasonable certainty we can estimate this temperature by the resistance of the graphite to this reagent.

Judging from the long time required to remove the superficial darkening from diamond, the graphite is as resistant as that formed at the temperature of the electric arc.

On one occasion when I had blackened the surfaces of diamonds by molecular bombardment *in vacuo* M. Moissan was present, and took some away with him for further examination. He subsequently reported the results in the *Comptes rendus*, vol. cxxiv., No. 13. He heated the diamond to 60° in an oxidising mixture of potassium chlorate and fuming nitric acid prepared from monohydrated sulphuric acid and potassium nitrate fused and quite free from moisture. The action on the black layer is very slow. There is produced graphitic oxide, which at an increased temperature yields pyrographitic acid, which is easily destroyed by nitric acid. Hence the variety of carbon which coated the diamond was graphite. The transformation of diamond into graphite requires the high temperature of the electric arc. The higher the temperature to which graphite is raised the greater is its resistance to oxidation. M. Moissan concludes that the temperature reached by the surface of the diamond in my radiant matter tubes is probably about 3600°.

The β-rays from radium having like properties to the kathode stream in a radiant matter tube, it was of interest to ascertain if they would exert a like difference on diamond. Two Bingara diamonds, A and B, weighing respectively 0·960 and 1·020 grains, were selected as near as the eye could judge of the same size and colour—very pale yellow, technically known as "off colour." Diamond A was put in a drawer far removed from radium or any radio-active body. Diamond B was kept close to a quartz tube containing about 15 milligrams of pure radium bromide sealed *in vacuo*. It phosphoresced brightly and continued to glow the whole time of the experiment.

After a fortnight the two diamonds were put side by side and compared. I could see no appreciable difference in colour between them. Diamond B was now replaced close to the quartz tube of radium, and they were kept in contact for six weeks. At the end of that time examination again showed scarcely any difference between the two. The one which had been near the radium might be a little the darker of the two, but the difference was too slight to enable me to speak positively.

Diamond B was now put inside a tube with radium bromide, the salt touching it on all sides, as it was thought possible that a screen of quartz might interfere with the passage of emanations which would act on the diamond. The comparison diamond was kept removed from the emanations as before. The experiment was continued for seventy-eight days, when the two diamonds were again examined. There was now a decided difference in colour between them; diamond A was of its original pale yellow "off colour," and diamond B was of a darker appearance and of a bluish tint, with no yellow colour apparent.

It thus appears that the property which radium emanations possess of darkening transparent bodies which they impinge upon—a property very marked in the case of glass, and less with quartz—also holds good in the case of diamond.

Diamond B was now heated to 50° C. in a mixture of strongest nitric acid and potassium chlorate for ten days, the mixture being renewed each day. At the end of this time the diamond had lost its dull surface colour, and was as bright and transparent as the other stone, but its tint had changed from yellow to a pale blue-green.

The radium emanations have therefore a double action on the diamond. The β-rays (electrons) effect a superficial darkening, converting the surface into graphite in a manner similar to, but less strongly than, the more intense electrons in the kathode stream. But the alteration of the body colour of the stone by emanations which are obstructed by the thinnest film of solid matter, even by a piece of thin paper, is not so easy to understand. A superficial action might be expected, but not one penetrating through the whole thickness of the diamond. I believe the alteration

[1] Read before the Royal Society on June 16 by Sir William Crookes, F.R.S.

[2] At a lecture before the Royal Institution on June 11, 1897, I exposed a flat macle crystal of diamond to radiant matter bombardment before the audience for about five minutes, a strip of metal covering part of the stone. On removing the diamond from the vacuum tube and projecting its image on the screen with the electric lantern, the image of the darkening was very apparent.

of colour is a secondary effect; in presence of radium the diamond is extremely phosphorescent, and it continues to shine during the whole time of the experiment. This constant state of vibration in which the diamond was kept for many weeks may have caused an internal change revealing itself in a change of colour. Indeed, it is not difficult to suppose that a chemical as well as a physical action may result. If the yellow colour is due to iron in the ferric state a reduction to the ferrous state would quite account for the change of colour to a pale blue-green.

This alteration of colour may be of commercial importance. If "off colour" stones can be lightened their value will increase, while if the prolonged action of radium is to communicate to them a decided colour they would be worth much more as "fancy" stones.

[*Added June* 16.—After the ten days' heating in the above acid mixture the two diamonds were put together in a glass tube and carried about for twenty-five days, sometimes loose and sometimes in the tube. They then were laid near together on a sensitive film in total darkness for twenty-four hours. On developing, diamond B had impressed a strong image on the film, but only a very faint mark could be seen where the other diamond had been. Probably this slight action was due to a little radio-activity induced in A during its twenty-five days' proximity to B.

The experiment was then repeated for confirmation, allowing the diamonds to remain on the sensitive surface for only five hours. On development, a good image of diamond B was seen, but not so black as in the former case.

The fact that diamond B was strongly radio-active after it had been away from radium for thirty-five days, for ten of which it was being heated in a mixture powerful enough to dissolve off its outer skin of graphite, seems to me proof that radio-activity is by no means a simple phenomenon. It not merely consists in the adhesion of electrons or emanations, given off by radium, to the surface of an adjacent body, but the property is one involving deep-seated layers below the surface, and like the alteration of tint is probably closely connected with the intense phosphorescence the stone had been experiencing during its seventy-eight days' burial in radium bromide.]

THE MARKINGS AND ROTATION PERIOD OF MERCURY.

MUCH new light was thrown upon the rotation period of Saturn during the year 1903, and it seems highly probable that the next planet to afford us information as to the same feature will be the planet Mercury. Spots of very definite and distinct character are certainly visible on the surface of this fugitive little orb, which offers a more promising field for new discoveries than Venus, though it is considerably smaller, at a much greater distance from us, and more unfavourably placed for observation. The markings sometimes perceptible on Mercury appear to be of sufficient prominence to be followed, and if really capable observers are forthcoming, at the opportune period, to study them, it will be possible to ascertain once and for all whether this circumsolar planet turns on its axis once in about 24 hours or 88 days, and an important advance in our knowledge will have been made.

Spots have been discerned on Mercury since the time of Schroeter about a century ago. Among those who have obtained observations of them are the following:—

Schroeter	1800	Denning	1882
Harding	1801	Schiaparelli ...	1882–3
Bessel	1801	Brenner	1896
Prince	1867	Lowell	1896
Birmingham ...	1870	Barnard	1900
Vogel	1871	McHarg .. .	1904

In 1800 Schroeter announced that the rotation period was about 24h. 4m. from blunted appearances of the southern horn, but doubted if the value could be determined to within a few minutes. In 1801 Harding perceived a dusky spot in the southern hemisphere, and derived the period as 24h. 5m. 30s. Further observations, however, obtained by himself and Bessel caused him to reduce this period to 24h. 0m. 50s. Bessel found 24h. 0m. 53s. from several of Schroeter's observations extending over fourteen months. In 1882 Denning, at Bristol, thought a period of about 25 hours would satisfy the observations, but Schiaparelli, in the pure Italian sky, arrived at very different results, and concluded that the planet rotated in 88 days, or in the same period as he revolved round the sun. Quite recently McHarg found the time 24h. 8m. from his own observations of a dark spot in April, 1904. He also deduced a period of 24h. 5m. 48s. from a blunting of the southern horn seen by Schroeter in 1800 March, and by Denning in 1882 November.

ON THE DIMENSIONS OF DEEP-SEA WAVES, AND THEIR RELATION TO METEOROLOGICAL AND GEOGRAPHICAL CONDITIONS.[1]

THE following table has been compiled from the original sources after re-calculating the true velocities corresponding to the "Beaufort numbers" in accordance with the alteration of reduction factor adopted by meteorologists since the date of the observations:—

Table showing the Relation between the True Velocity of the Wind in Statute and in Geographical Miles per Hour and the Height of the Wave in Feet, as deduced from Observations by numerous French Observers extending over many years and taking in all the Oceans.

No. of wind on Beaufort's scale of 0–12	Velocity of wind, stat. miles per hour	Velocity of wind, geographical miles per hour	Height of wave in feet	Authority	Velocity of wind in stat. miles per hour divided by height of wave in feet	Velocity of wind in geographical miles per hour divided by height of wave in feet
						Feet
0·00	2·0	1·7	1·97	Desbois	1·01	0·86
1·50	5·5	4·8	3·28	,,	1·68	1·46
3·00	10·0	8·7	4·92	,,	2·03	1·77
3·60	12·4	10·8	6·17	Antoine	2·01	1·75
4·36	15·8	13·7	6·56	Paris	2·41	2·09
4·50	16·5	14·3	7·55	Desbois	2·19	1·89
4·80	18·0	15·6	9·12	Antoine	1·97	1·71
5·45	21·7	18·9	13·45	Paris ("Grosse Houle")	1·61	1·41
6·00	25·0	21·7	10·83	Desbois	2·31	2·01
6·00	25·0	21·7	13·12	Antoine	1·91	1·65
6·55	28·3	24·6	11·65	Paris	2·43	2·11
7·20	32·2	28·0	17·0	Antoine	1·89	1·65
7·50	34·0	29·5	15·42	Desbois	2·20	1·91
8·18	38·3	33·3	16·57	Paris	2·31	2·01
8·40	39·8	34·6	16·73	Antoine	2·38	2·07
9·00	44·0	38·2	20·67	Desbois	2·13	1·85
9·60	49·2	42·7	21·98	Antoine	2·24	1·94
9·82	52·2	45·3	25·43	Paris	2·05	1·78
10·50	58·2	50·5	28·54	Desbois	2·04	1·77
10·8	61·8	53·7	27·89	Antoine	2·22	1·93
				Average	2·03	1·78

This table gives the average of many hundreds of days' observations conducted at various times during a period of about forty years by independent observers, all French seamen of the navy or merchant service, carried out in almost all parts of the oceans ordinarily visited by ships, and from many different vessels (none, however, of the great size of our modern liners, and therefore better for such observations), and shows the average height of the wave, in open sea with sufficient depth of water, to be in simple arithmetical proportion to the velocity of the wind, *the height of the wave in feet being in round numbers one-half of the velocity of the wind in statute miles per hour.*

This result does not express a dynamical law; it is simply

[1] Extracted from a paper by Dr. Vaughan Cornish in the *Geographical Journal* for May, 1904.

the result of averages, but if confirmed by further observation it will have considerable interest for geographers, meteorologists, and for those who have to do with the sea.

We may take 20-feet average waves and 30-feet occasional waves as the limit in very severe gales in the "seas," and 30-feet average and 45-feet "ordinary maximum" waves as the limit of wave-height for the oceans. Although strong winds will push short waves to a considerable steepness, yet they are not able to attain quite so great a height as somewhat longer waves, because, moving more slowly, their tops give way under the great difference of wind-pressure upon their two sides. Thus the development of the larger waves primarily depends upon the opportunity to attain greater *length*. It is in this respect that our consideration of the size of the cyclone becomes so important for deep-sea waves, especially for explaining the co-existence of the steep storm waves with the swell.

The slighter development of the longer waves is undoubtedly influenced by the dual circumstance that the length of fetch of wind of the required velocity diminishes (the stronger winds only blowing for a short *time* at a fixed station, or for a short *space* in the travelling cyclone), whilst the requisite fetch is greater, for it must be a *large multiple of the wave-length*. Thus the limit of length of the steep waves is rapidly approached from the concurrence of the two causes operating, so to speak, from opposite directions.

Taking T. Stevenson's table ("Enc. Brit.," ninth edition, art. Harbours) of the relation of height of waves to length of fetch, and multiplying the heights by twenty (as a first approximation) to obtain the length, we see that a considerable wave does not become the dominant form except with a fetch *approaching* 2000 *times its wave-length*.

Extending these results to 30-feet (average) waves 600 feet long, *i.e.* fully grown ocean storm waves, we see that 30-feet $\times$ 20 $\times$ 2000 = 227 statute miles, or 197 geographical miles.

A 9-hours' blow, with wind 64 miles per hour, was recorded in the gale of December 22, 1894. With the average velocity of advance of deep depressions from W.S.W. on our coast, viz. 24·8 (say 25) knots, this would give a length of fetch of 225 geographical miles. The height of wave corresponding to this length of fetch in severe gales, as calculated by stretching Stevenson's formula, is 22·5 feet. If the cyclone had the exceptional speed of 60 knots, the length of fetch of the 64-mile-an-hour wind would be 450 miles, which with Stevenson's formula gives a height of 31·8 feet. A thirty-foot wave from the same formula requires a length of fetch of 400 miles. Both this length of fetch and this height of wave are probably more normal in the southern ocean than in the North Atlantic; the 22·5-foot wave and the 225-mile length of fetch would be more the scale of things there.

If we take the case of a very long swell of 2000-feet wave-length (unusual, but within the records), which is one-third of a geographical mile, then 2000 times this wave-length is 666 miles. The speed of such a swell is 69 knots, and wind of greater velocity than this would only be blowing in a comparatively short strip of even a great cyclone. They would, therefore, not be developed into the dominant wave form, however strong the wind might be there. The reason for this is most easily understood if we imagine a short series of such waves to exist with the steepness of ordinary storm waves. If 76-miles-per-hour wind last one hour at a fixed station (which occasionally happens on our coasts), and the rate of advance of the storm be 25 miles per hour, then the stretch of water at any time exposed to the above force of wind is 25 miles, which would comprise only 75 such waves.

Suppose these, or any of them, to have attained considerable steepness, it is evident that the arrangement would be unstable, for there would be so great a difference of steepness between neighbouring waves that the group would speedily extend itself, multiplying the number of its waves and flattening them out, until the gradation from one wave to the next is almost indefinitely small.

Although the length of fetch in cyclones is inadequate to the development of the longer observed swells to great steepness, the length of run of the cyclones on the oceans is frequently such as afford much more than the time required for the full development of ordinary storm waves. Thus a cyclone travelling a little less than 25 knots, the average speed of deep depressions approaching our shores from the Atlantic, travels with the group velocity of a swell of 16-seconds' period (or 1311-feet wave-length), the speed of such waves being 48·56 knots, and their group velocity being, therefore, 24·28 knots. Such a storm, if brewed in mid-Atlantic, and advancing on our shores from W.S.W., would continually reinforce this swell during three days, a space of time equal to 16,200 times the period of the wave.

It is an interesting coincidence that the average velocity of deep depressions approaching our coasts from points between W.S.W. and W.N.W. (25 knots) is about half that wind velocity called "a severe gale" by Brodie (viz. Beaufort's 10, 53 statute miles per hour, 46 knots). Of the sixty recorded cases of more rapidly advancing storms, twenty-five had a speed of 31 to 34 knots, which is again about half the maximum observed wind velocity (except in gusts).

Thus we have a dual correspondence of velocities, the individual wave of the longest swells moving with nearly the velocity of the strongest winds, and the group of swells advancing with nearly the velocity of the great storms.

When, as often happens (in the North Atlantic), a long swell precedes and predicts the arrival of a storm, the rate of advance of the latter is less than half the speed of this swell in deep water.

A slowly moving storm with violent winds will raise a short steep sea with comparatively little swell in it.

The rate at which a wave flattens out when the wind ceases is inversely as the square of its length. Consequently, in oceans large compared with the areas of cyclonic storms, the surface is found to be heaving with a long swell during the intervals between storms (whence the grand surf which rolls in upon oceanic islands). New storms will not, as a rule, catch up a group of such swells, but cyclones brewed upon the ocean find such a swell already running, and, travelling with it, soon increase its steepness. This is particularly true of the circumterrestrial waters of the southern hemisphere, where a long swell from the west is always running.

It is probable (and experience at sea supports the opinion) that in moderately high latitudes of the southern hemisphere, say 40° to 60° S., the cyclones are on a larger scale than in the corresponding latitudes of the northern hemisphere, where atmospheric movements are more broken up by the alternation of land and water. The bigger waves of the southern ocean I attribute only indirectly to the greater expanse of water. The expanse of water in the northern Pacific and northern Atlantic would amply suffice for the development of larger waves than actually occur there were the storms which traverse them framed on a larger scale.

GEOLOGY IN NORWAY.

THE last "Year-book of the Norwegian Geological Survey" (1903) contains five papers bearing on different subjects concerning the geology and topography of Norway.

In the first paper, the aged mining engineer Mr. Friis deals with Jurassic coal beds on the Andö, an island in northern Norway. The sandstones and slates of the Brown Jura contain good cannel coal of 1 metre thickness, but cover rather a small area.

In the second paper, Dr. H. Reusch, the chief of the Survey, describes a journey through the interior of the most northern province of Norway, a desolate and almost uninhabited country, to visit the gold fields near the Russian border. Gold occurs in a Glacial deposit, "aas" or esker, but only in small quantities. Dr. Reusch describes the country upon the whole as a peneplain 300 to 500 metres above the sea. Glacial deposits widely cover the land, and solid rock, mostly archæan and sandstones of supposed Devonian age, is only seldom seen.

In two papers, Mr. Kaldhol and Mr. Rekstad deal with the succession on "Hardangervidda," the wide plateau on an average 1300 metres above the sea, with peaks ranging

almost to 2000 metres, to the east of the Hardangerfjord. On the underlying granite rests a phyllite series, containing at the base black schists with *Dictyonema flabelliforme*, giving the series a place within the Upper Cambrian and Lower Silurian. But above this phyllite, and perhaps concordantly, rest metamorphic schists, beginning with quartzite beneath and ending in a coarse, typical gneiss. Some geologists are inclined to think this inversion due to an immense overthrust. The boundary between the granite and the phyllite is very level, and Mr. Rekstad suggests the surface of the granite to be an Archæan or Cambrian peneplain. The paper is accompanied by a coloured map of the region.

In the last paper Mr. Rekstad shows that the upper limit of the mountain forests has of late subsided 300 to 400 metres in southern Norway, pointing to a decrease in temperature of 2·1° to 2·4° C. In the time of mild climate glaciers must have been almost absent. He places this time to the age of the *tapes*-banks, when the land had performed about four-fifths of its total upheaval since the close of the Glacial period.

The papers are all illustrated by photographs and diagrams. They are written in Norwegian, but each is accompanied by a summary in English. A. D.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—At the Encaenia on June 22, the honorary degree of D.Sc. was conferred upon the following:—The Hon. C. A. Parsons, Mr. Marconi, Sir William S. Church, Sir Andrew Noble, Sir William Crookes, Sir David Gill, Sir John Murray, Prof. Alfred Marshall, Prof. J. J. Thomson, Prof. Horace Lamb, Prof. A. R. Forsyth, Prof. J. Dewar, and Prof. J. Larmor.

Cambridge.—In the natural sciences tripos forty-five men and one woman have gained first classes in part i.; thirteen men and three women have gained first classes in part ii.

The Raymond Horton-Smith prize, for the best M.D. thesis of the year, has been awarded to Dr. F. A. Bainbridge, Trinity. Dr. B. N. Tebbs, Queens', receives honourable mention.

The Harkness studentship in geology has been awarded to Mr. O. T. Jones, Trinity.

Dr. H. B. Roderick, Emmanuel, has been appointed demonstrator of surgery.

The Frank Smart studentship of 100*l*. a year for research in botany will be filled up in July. Applications must be sent to the Vice-Chancellor by July 13.

The degree of doctor of science was conferred on Prof. C. S. Sherrington, F.R.S., at the congregation on June 18.

The Wiltshire prize for geology and mineralogy is divided between H. A. Wootton, Clare, and J. A. Crowther, St. John's.

The Hockin prize for physics at St. John's is also divided, between S. H. Phillips and J. A. Crowther.

The Hutchinson studentship for research in physics is awarded to E. Gold, bracketed third wrangler 1903.

Mr. W. G. Fearnsides (natural sciences tripos, 1900) has been elected a fellow, and Dr. E. H. Griffiths, F.R.S., principal of Cardiff University College, has been elected an honorary fellow, of Sidney Sussex College.

Dr. O. Aschan has been appointed professor of chemistry at Helsingfors.

The following honorary degrees were conferred at a convocation of the University of Durham on June 22:—D.C.L., Sir Daniel Morris; D.Sc., Prof. R. A. Sampson, F.R.S.; D.C.L., Dr. Harold F. Wilson; D.Sc., Mr. David Woolacott.

The first number of the second volume of the *Investigations* of the Departments of Psychology and Education of the University of Colorado has been received. It contains papers by Mr. F. H. Clark on the scope and efficiency of the normal schools of the United States; by Prof. Libby on co-education and the raw material of the school; and by Mr. J. H. Bair on factors in the learning process.

The programme containing regulations for the registration, conduct, and inspection of classes and examination of candidates in technological subjects, and for the award of teachers' certificates in manual training and domestic economy, for the session 1904–5, in connection with the City and Guilds of London Institute, has now been published. The programme may be obtained from Mr. John Murray, price ninepence net.

We have received from Messrs. Swan Sonnenschein and Co., Ltd., a copy of a useful publication compiled from official records by the editor of the "Schoolmaster's Yearbook and Directory." The title and subtitle serve to indicate satisfactorily the scope of the new volume, which is called a "Register of Teachers for Secondary Schools," being the list of teachers registered in column B of the Teachers' Register, formed and kept by the Teachers' Registration Council, in accordance with the Order in Council, March 6, 1902, and amending orders. Particulars of address, date of registration, qualifications, experience, recorded in the register for each teacher, are also given. The volume costs two shillings net.

A paper read last July at the meeting of the National Educational Association at Boston, Mass., U.S.A., by Prof. W. N. Rice, on the proper scope of geological teaching in the high school and academy, has been reprinted in separate form from the *Proceedings* of the National Educational Association. From a copy of the reprint which has reached us, we learn that Prof. Rice believes "that there should be a required course in physical geography in the first year of the high-school curriculum." The geographical course would by this plan precede the bifurcation of the curriculum necessitated by the fact that in most cases the classical students must begin Greek in the second year. Prof. Rice also considers that a course in geology, which should be chiefly dynamical and structural geology, is a most desirable elective in the fourth year of the curriculum.

The University College of North Wales has organised a department of forestry or sylviculture in connection with its agricultural department. The desirability of providing facilities for the teaching of forestry in North Wales was brought prominently forward by Lord Onslow some months ago in his address at the opening of the College Farm at the commencement of the present session, and it is gratifying to find that the proposed scheme has so soon been realised. Mr. Fraser Storey has been appointed lecturer in forestry. Not only will the Bangor School of Forestry be the first institution of its kind organised in connection with a university college in this country, but a further innovation has been made in extending the work of the department beyond the limits of ordinary class-teaching. A considerable portion of Mr. Storey's duties will consist in acting as an expert adviser in connection with the principal estates in the district, on which the development of forestry is desirable.

The Earl of Onslow on Friday last, June 24, opened the gardens of the horticultural department of University College, Reading, in his official capacity as President of the Board of Agriculture. It may be pointed out that for some years Mr. Frederick Keeble has given instruction in the principles of horticulture, but only comparatively recently is it that, owing to the kindness of Mr. Alfred Palmer in putting seven acres of land, conveniently placed, at the disposal of the college, justice has been done to the practical side of the work. At the ceremony to which we have referred, the principal, Mr. W. M. Childs, answered the question as to why horticulture is necessary, and gave three reasons:—(1) the enormous increase in scientific knowledge as to the growing of plants; (2) foreign competition; and (3) the training of teachers in connection with rural education. Lord Onslow, in a brief speech, emphasised the remarks of the principal; he dwelt particularly on the third point, and alluded to the need for properly presenting produce to the purchaser. Mr. Martin J. Sutton afterwards said that never before had he attended a meeting at which the teaching of horticulture had received the official recognition of the Government. Seeing the hard struggle which has been made to introduce such teaching of horticulture as gives proper attention to the scientific side, the results which we chronicle are most satisfactory.

THE academic address to the University College of North Wales was delivered on Friday last by Sir Arthur Rücker, F.R.S., principal of the University of London, who chose as his subject "University Organisation in Great Britain." Sir Arthur Rücker traced the various phases through which the university systems of our country had passed, starting with the residential university, represented at the present time by Oxford and Cambridge (and in former days by Stamford). Next in order of development came the purely examining University of London, which led to the formation of provincial university colleges. The federal university came next in the Victoria University and University of Wales. The University of Birmingham represented a new phase, namely, the municipal university, of which at the present time there were two representatives in Lancashire and two in Yorkshire. The impossibility of raising by private subscriptions sufficient funds for the endowment of universities and university colleges resulted in the necessity of Government subsidies, and a great deal more ought to be expected in this direction in the near future. In the further development of university organisation a number of interesting questions would have to be answered. These related to such points as how far Government assistance was to be given to colleges and how far to universities, whether institutions partaking of the character both of colleges and universities should be subsidised under both headings, whether it was desirable to confer on new universities generally the powers of examining external students as provided for in the charter of the Birmingham University, and the extent to which universities subsidised at the same time by municipalities and the Government should be under the inspection of both bodies.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 2.—"Colours in Metal Glasses and in Metallic Films." By J. C. Maxwell **Garnett.**

The first part of the paper is devoted to coloured glasses. The phenomena which it seeks to explain were observed by Siedentopf and Zsigmondy.

It is proved in this paper that every medium made up of metal spheres embedded in a non-absorbing substance in such manner that the average distance between two adjacent spheres is much less than a wave-length of light has a perfectly definite colour, depending only on the optical constants of the metal of which the spheres are made, on the refractive index of the substance in which they are embedded, and on the quantity of metal present, but not on the size or distance apart of the spheres.

It is shown that the particles which Siedentopf and Zsigmondy observed in gold glasses are spherical when their diameters are less than 10^{-5} cm. The presence of the metal spheres accounts for the red colour of gold and copper ruby glass, and for the yellow colour of silver glass, and would give a blue-violet colour to "potassium-sodium" glass (potassium-sodium being an amalgam of which the optical constants have been determined by Drude).

Experiments are described proving that these characteristic colours can be produced in a colourless metal glass containing the metal in solution or in combination (the state in the manufacture of gold or copper ruby glass before the second heating) by the β radiation from radium.

The calculated properties of media containing many metal spheres to a wave-length of light account for the changes of colour, for the initial increase in absorption, and for the final change to almost complete transparency which Mr. G. T. Beilby observed during the annealing of gold and silver films. Explanations are given of the changes of colour on heating observed by Prof. R. W. Wood in potassium and sodium films deposited on the insides of exhausted glass bulbs. The increase in strength of colour which was generally observed in the light transmitted by these films when the plane of polarisation of obliquely incident light was changed from that of incidence to a perpendicular position is also explained.

Evidence is adduced to show that the allotropic silvers obtained by Carey Lea are further examples of this type of medium.

"A Method of Measuring directly High Osmotic Pressures." By the Earl of **Berkeley** and E. G. J. **Hartley.** Communicated by W. C. D. Whetham, F.R.S.

This is a preliminary paper describing the authors' method of determining high osmotic pressures. It is as follows:—

A porous porcelain cylinder, glazed only at the ends, has a copper ferrocyanide membrane deposited on its outer surface. The solution surrounds the cylinder, and the inside, which is connected to a graduated glass capillary, is filled with water. By means of a plunger, which works in a steel cylinder and is actuated by a lever and weights, pressure is put upon the solution. So long as this pressure is less than the osmotic pressure of the solution, water from the inside of the cylinder passes through the membrane into the solution, and consequently the water-level in the capillary falls. When the pressure on the solution is gradually increased, the rate at which the level falls gradually decreases, and this continues until the osmotic pressure of the solution is reached; then the level in the capillary is stationary. A further increase of pressure on the solution will then cause the level to rise. The rate of movement of the level in the capillary is a function of the difference between the osmotic pressure and the pressure on the solution, so that by observing the changes in this rate consequent on the corresponding changes in the pressure, the point at which the latter is equal to the osmotic pressure can be deduced. The results of some experiments with cane sugar, extending up to a solution having an osmotic pressure of 45 atmospheres, are given.

The semipermeable membranes are made partly by following Pfeffer and partly by a modification of Morse's electrolytic method. By this means a membrane that withstood 120 atmospheres pressure was obtained.

"On the Electric Effect of Rotating a Dielectric in a Magnetic Field." By Dr. Harold A. **Wilson.** Communicated by Prof. J. J. Thomson, F.R.S.

It was shown by Faraday in 1831 that an electromotive force is induced in a conductor when it moves in a magnetic field so as to cut the lines of force. The object of the experiments described in this paper was to see if a similar electromotive force is induced in a dielectric when it moves in a magnetic field.

According to Maxwell's electromagnetic theory as developed by H. A. Lorentz and Larmor, such an electromotive force should be induced in a dielectric, and should be equal to that in a conductor multiplied by the factor $1-K^{-1}$, where K is the specific inductive capacity of the dielectric.

The method employed was to rotate a hollow cylinder of ebonite in a magnetic field parallel to the axis of the cylinder. The inside and outside surfaces of the cylinder were provided with metal coatings, with which electrical contact was made by sliding brushes. The inside coating was connected to earth, and the outside coating to one pair of the quadrants of a sensitive quadrant electrometer, the other pair of quadrants being connected to earth. The magnetic field was then reversed, so reversing the induced electromotive force in the ebonite. The resulting electric displacement was measured by means of the electrometer, the quantity of electricity required to produce a given deflection of the electrometer needle being determined by means of a small parallel plate guard ring condenser.

The cylinder used was 10 cm. long and $2r_2=4\cdot15$ cm., $2r_1=2\cdot01$ cm. It was mounted in a solenoid having 95 turns per cm., by which a magnetic field of strength 1500 could be produced. The cylinder was driven by a $\frac{1}{2}$ horse-power motor, and could be run at 200 revolutions per second.

The mean result obtained for the quantity of electricity set free on the outside coating of the cylinder, on reversing the magnetic field, only differs from the amount calculated theoretically by 1 per cent. The specific inductive capacity of the ebonite, as determined by measuring the capacity of the cylinder, was 3·54, while the value calculated from the results obtained was 3·64.

The results obtained are thus in complete agreement with the theories of Lorentz and Larmor, and may be regarded as a confirmation of these theories.

June 9.—"On the Combining Properties of Serum-Complements and on Complementoids." By Prof. Robert **Muir** and Dr. Carl H. **Browning**. Communicated by Sir J. S. Burdon-Sanderson, Bart., F.R.S.

The following are the chief results obtained from the experiments described in this paper. It is, of course, to be understood that they are held to apply only to the cases investigated, viz. the immune-body for ox's corpuscles obtained from the rabbit, used along with rabbit's and guinea-pig's complements and complementoids. Further observations will be necessary to determine whether they obtain generally.

(1) The existence of complementoids in heated sera can be shown in ordinary test-tube experiments, by their preventing (*a*) the union of complement with anti-complement, (*b*) the union of complement with R+IB molecules after lysis.

(2) The amount of complementoid derived from complement as tested by the combining relationships varies; in the case of the rabbit it is approximately equal to the original amount of complement; in the case of the guinea-pig it is considerably less than that amount.

(3) The combining affinity of complementoid, both for anti-complement and for R+IB molecules after lysis, is not much inferior to that of complement.

(4) On the other hand, complementoid has a feeble affinity for R+IB molecules before lysis, *i.e.* for intact red corpuscles treated with immune-body; of the complementoid added only a small quantity enters into combination; hence complementoid does not prevent lysis by complement.

(5) When red corpuscles united with multiple doses of immune-body are lysed by a single dose of complement, the surplus R+IB molecules can be saturated with excess of complementoid, so that almost no complement can subsequently be taken up. This result is obtained also with rabbit's complementoid and guinea-pig's complement, and with guinea-pig's complementoid and rabbit's complement.

"On the Ossiferous Cave-Deposits of Cyprus." By Dorothy M. A. **Bate**. Communicated by Dr. Henry Woodward, F.R.S.

"Further Note on the Remains of *Elephas cypriotes*, Bate, from a Cave-Deposit in Cyprus." By Dorothy M. A. **Bate**. Communicated by Dr. Henry Woodward, F.R.S.

Entomological Society, June 1.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. E. B. **Green** exhibited various insects from Ceylon, including a "carpenter bee" (*Xylocopa fenestrata*, Fab.) and a large asilid fly (*Hyperechia xylocopiformis*, Wlk.) which very closely mimics it; specimens of a Mycetophilid fly and cocoons from which they emerged, showing their beautiful structure; and examples of a tineid moth with remarkable larval cases.—Mr. H. St. J. **Donisthorpe** exhibited specimens of the rare *Tachys parvulus* from the New Forest.—Mr. J. E. **Collin** exhibited specimens of *Mochlonyx velutinus*, a rare British Culicid which he, in company with Messrs. Verrall and Wainwright, had found in numbers near Beaulieu, in Hampshire, on May 22.—Mr. A. J. **Chitty** exhibited an Ophionine ichneumon with the pollen of an orchid firmly attached to the head, making the insect look as though it was attacked by fungus.—Mr. C. P. **Pickett** exhibited long series of *Angerona prunaria* and *Lycaena corydon* showing the remarkable range of variation in both species.—The **President** exhibited specimens of *Paltothyreus tarsatus*, Fabr., an ant belonging to the family Poneridæ, recently received from Dr. S. Schönland, who mentioned that about eight miles west of Palapye Road Station, Cape Colony, he had noticed an awful stench, which, however, passed off after a time. It turned out afterwards that it emanated from these ants living in trees.—The **President** also exhibited a cluster of the green eggs of *Vanessa urticae* fixed to the under-side of a small leaf towards the summit of a nettle-stem. The cryptic resemblance of the eggs to their environment was very remarkable. He then read a note on the courtship and pairing of the species.—Dr. T. A. **Chapman** exhibited two very interesting Erebias caught by the president on the Guadarrama (near Madrid, Spain) on July 25, 1902, at an elevation of about 6000 feet. Though taken together and very much alike, they proved to be of two species, viz. *E. evias* and *E. stygne*, both males. He remarked that the same two species which he found last year in Spain associated together and closely resembled each other, which is not their habit in Switzerland. He also exhibited the ova, larval work, pupæ, and imagines of Anthomyiina, sp., a dipteron that lays its eggs on a fungus, *Epichloe typhina*, Buk., common in June on grass stems. He had often wondered at the curious way of life of this larva, living under a case and burrowing out on the surface of the fungus, making labyrinthine tracks when it ate the incipient spore-bearing layer.—Mr. H. J. **Turner** exhibited several species of the lepidopterous genus Coleophora, and contributed notes on them.—Colonel Charles **Swinhoe** read a paper on tropical African Geometridæ in the national collection.—Mr. W. L. **Distant** communicated a paper entitled "Additions to a Knowledge of the Family Cicadidæ."—The president communicated a paper by Mr. G. F. **Leigh** entitled "Synepigonic Series of *Papilio cenea* (1902–3) and of *Hypolimnas misippus* (1904), together with Observations on the Life-history of the Former," and exhibited specimens to illustrate the same.—Mr. Edward **Saunders**, F.R.S., communicated a paper on Hymenoptera Aculeata from Majorca (1901) and Spain (1901–2).

Zoological Society, June 7.—Dr. F. DuCane Godman, F.R.S., vice-president, in the chair.—A communication from Lieut.-Colonel J. Malcolm **Fawcett** contained descriptions of ten species of butterflies, mainly from high elevations in the north-eastern Himalayas. Eight of them were new species or varieties.—Dr. A. G. **Butler** contributed a paper on seasonal phases in butterflies.—Captain Richard **Crawshay** read some notes on the prey of the lion, and exhibited some tips of porcupine quills that had been found buried in a lion's fore paws, together with the skull and skin of the lion.—Mr. F. E. **Beddard**, F.R.S., read the following papers, based on observations he had made in the society's prosectorium:—(1) Note on an apparently abnormal position of the "brephos" within the body of a skink; (2) contributions to the knowledge of the visceral anatomy of the pelagic serpents *Hydrus platyurus* and *Platyurus colubrinus*; and (3) on the presence of a parasternum in the lacertilian genus Tiliqua, and on the poststernal ribs in that genus.—A communication from Dr. E. A. **Goeldi** contained a description and an account of the habits of the rare rodent *Dinomys branickii*, Peters, specimens of which had recently been received at the Goeldi Museum, Pará.—A communication from Dr. C. **Satunin** contained a description of the black wild cat of Transcaucasia.—A paper was read from Mr. R. **Lydekker** containing the description of a new race of buffalo from East Central Africa. A second paper by Mr. Lydekker contained the description of a new species of deer from Ichang.—Dr. A. Smith **Woodward**, F.R.S., read a paper on two new labyrinthodont skulls which had recently been acquired by the British Museum. One was from the Triassic sandstone of Staffordshire, and the other from a formation of apparently the same geological age in Spitsbergen.

Geological Society, June 8.—Dr. J. E. Marr, F.R.S., president, in the chair.—The palæontological sequence in the Carboniferous Limestone of the Bristol area: A. **Vaughan**. The zonary divisions established are given in a table in the form in which they are finally set out. The corals and brachiopods are chosen as zone and subzone fossils, and genera are selected for zone-indices and circuli (or species-groups) for subzonal indices. To secure definiteness photographic figures are introduced. The relative acceleration of the two groups employed is not identical in different localities, and there is a small relative displacement of one group upon the other. The stratigraphy of all the important sections and isolated exposures in the Bristol area is dealt with. In each case is given a description of the position at which each zone or subzone is exposed and of its lithology, a list of the corals and brachiopods found, and a comparison with the same horizon in other parts of the Bristol area. The author claims that in the area with which he deals, his table of ranges is sufficient to enable any worker to zone any exposure with a considerable degree of accuracy.—On a small Plesiosaurus-skeleton from the White Lias of Westbury-on-Severn: W. F. **Gwinnell**. The matrix of the specimen corresponds

with the White Lias. The remains include more than twenty dorsal vertebræ, with spinous and transverse processes, lying in natural sequence. A pseudomorph of the spinal cord in calcite occurs also in position. Hitherto only single vertebræ or fragmentary bones of Plesiosaurus have been recorded from this horizon in Britain. At present, it has not been found possible to assign the fossil to any existing species.—The evidence for a non-sequence between the Keuper and Rhætic series in N.W. Gloucestershire and Worcestershire: L. **Richardson.** The section at Wainlode Cliff shows a transition in the "bone-bed," from a thin pyritic stratum, crowded with fish-remains, to a micaceous sandstone-bed, usually devoid of such remains and about a foot thick. This sandstone may be called the "bone-bed-equivalent." As the bone-bed can be traced in a single section laterally into a sandstone-bed devoid of those remains, the contemporaneity of the two developments is considered established. Above the main bone-bed the deposits of the Rhætic are persistent, but not below. Black shales are generally present below the bone-bed in Worcestershire, but in places there comes in a sandstone between it and the "tea-green marls." It is found that the greatest thicknesses of the Rhætic rocks under the bone-bed coincide with synclines, and the least thicknesses with anticlines. Thus the earth-pressures recognised in later times were probably at work at the close of the Keuper period. As the area once covered by the waters of the Keuper sea gradually sank, the Rhætic ocean slowly encroached upon the land-surface, and successive overlaps of the several infra-bone-bed deposits resulted.

Physical Society, June 10.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—Prof. H. L. **Callendar** gave a demonstration of the projection of the indicator diagrams of a petrol motor. The lantern-slides illustrated the working of the motor under various conditions, and were prepared to elucidate the nature of some of the defects which occur in practice. The motor itself was exhibited in action, with the indicator attached, and the actual diagrams were projected on the screen showing the changes of form as they occur when the conditions of running are changed. The motor employed was a Clement-Garrard cycle-motor, with 60 mm. bore and 70 mm. stroke. The engine, like most other internal combustion engines, works on the four-stroke cycle of operations—suction, compression, explosion, and exhaust—and runs at speeds varying from 2000 to 2500 revolutions per minute.—A model illustrating the propagation of an alternating current along a telephone cable, and a simple theory of the same: Prof. J. A. **Fleming.** Although the mathematical theory of the propagation of alternating currents along lineal conductors having capacity, inductance, resistance, and leakage has been developed by many writers in great fulness, the conclusions reached by them have not always been readily assimilated by practical engineers, and in some cases unsound theories have been put forward regarding the conditions limiting telephonic speech along wires. The present paper contains an account of a model (exhibited at the meeting) which has been constructed by the author for the purpose of explaining in a simple manner the physical meaning of the mathematical expressions which are reached in discussing the propagation of alternating currents along a telephone or telegraph cable. Mr. M. E. J. **Gheury** exhibited a gyroscopic collimator. The instrument is used in connection with an ordinary sextant, the observation being taken as with the sea horizon by bringing the image of an observed body into a field of vision, in which a horizontal grating of a special kind allows the observer to ascertain the direction of the true horizon.

Linnean Society, June 16.—Prof. W. A. Herdman, F.R.S., president, in the chair.—Mr. R. Brooks **Popham** sent for exhibition some calculi from the horse: two of very large size were obtained *post mortem* from a cart-horse employed in hauling coal; a third specimen from the same animal, on being broken, showed the nucleus to be a piece of coal, probably swallowed with its food. Another large stone was associated with many smaller, from a second horse—nearly one hundred in all. The specimens had been obtained from the stomach or intestinal canal of the animals.—Canon F. C. **Smith** sent for exhibition a handsome inflorescence of a scrambling shrub from Freetown, Sierra Leone, in habit resembling our native *Clematis Vitalba*. It proved to be *Rhynchosia calycina*, Guill. and Perr., which is widely spread in tropical Africa, reaching Rhodesia.—On variations in the arrangement of hair on the neck of the domestic horse: Dr. Walter **Kidd.** The author sought to test the validity of the theory that certain phenomena in the arrangement of hair in mammals are produced by mechanical causes. Numerous observations of the changes from a primitive type were figured and described. These changes, being shown to be congenital and of mechanical origin, were held to be instances of the inheritance of acquired characters.—An account of the Jamaica species of Lepanthes: Dr. **Rendle** and W. **Fawcett.**—On blaze currents of vegetable tissues: Dr. A. D. **Waller,** F.R.S. The author showed that these currents were symptomatic of the living tissue, and were not shown by dead organisms. In experimenting upon peas (*Pisum sativum*) the author mentioned the need of access to a garden, in order that the material might be gathered in proper condition, for certain experiences showed that garden produce obtained in the ordinary course from a market had suffered so much from bruising as to be worthless in these experiments.—On British freshwater Rhizopoda: J. **Cash.**—On the place of Linnæus in the history of botany: P. Olsson **Seffer.**

Royal Statistical Society, June 21.—Major P. G. Craigie, C.B., president, in the chair.—In a paper entitled "Observations on the Production and Consumption of Meat and Dairy Products," Mr. **Rew** summarised the conclusions of the committee of the society on both branches of their inquiry. The results suggested that the average consumption per head in this country was, of meat 121·8 lb., of milk 15 gallons, of cheese $10\frac{1}{2}$ lb., and of butter $18\frac{1}{2}$ lb. The meat included 56·8 lb. of beef and veal, $27\frac{1}{2}$ lb. of mutton and lamb, and 36·8 lb. of bacon and pork, but these quantities did not supply all the carnivorous demands of the population, as poultry, game and rabbits, as well as what butchers termed the "fifth quarter," were not included. In the case of milk, allowance should be made for the consumption of separated or skim milk, and also for condensed milk, neither of which was included in the average of 15 gallons. Reference was made to previous estimates, and it was suggested that the home production, both of meat and milk, had increased in recent years, though by no means sufficiently to keep pace with the growth of population. Some figures representing the estimated consumption in certain European countries, in the United States, and in Australasia, were given, and as the result of the comparison Mr. Rew observed that we appear to be well ahead of other European nations in meat consumption, but appreciably behind our American cousins, and remarkably less carnivorous than our Australasian brethren.

DUBLIN.

Royal Irish Academy, June 13.—Prof. R. Atkinson, president, in the chair.—Mr. George **Coffey** and Mr. R. Lloyd **Praeger** read a paper on the Antrim raised beach, in which they discussed the question of post-Glacial oscillations in northern Ireland, their extent and age. Their conclusions point to a submergence, of which the later part amounting to at least 20 feet, is early Neolithic in age, followed by an emergence of some 30 feet, which is later Neolithic, the only post-Neolithic movement being a slight submergence. The area affected by these movements embraces northern England, southern Scotland, and northern Ireland. Beyond this area, the Neolithic emergence appears to be absent.

PARIS.

Academy of Sciences, June 20.—M. Mascart in the chair.—Emanations and radiations: M. **Berthelot.**—On stability of equilibrium: Paul **Painlevé.**—On a new carbide of molybdenum, MoC: H. **Moissan** and K. **Hoffmann.** Molybdenum resembles tungsten and chromium in forming more than one carbide. The compound MoC described in the present communication is formed by heating molybdenum, aluminium, and lamp black together in the electric furnace. It is crystalline, harder than quartz, is attacked by acids with difficulty, except nitric acid, and is not decomposable by water.—The influence of discontinuity of muscular work on the energy expenditure: A. **Chauveau.**

—On the general theory of fundamental functions: W. **Stekloff.**—On the theory of spherical functions: Niels **Nielson.**—On the exceptional case of M. Picard and multiform functions: G. **Remoundos.**—On the construction of aërostats: Ch. **Renard.**—On the refractive powers of dissolved substances: approximate laws: C. **Chéneveau.** Generalisations of the experiments made by the author and by Dijken. It is shown that there is a constant ratio between the molecular refractive power of substances in solution and the square root of the molecular weight.—On the spectrum of calcium fluoride in the electric arc: Ch. **Fabry.** Most salts introduced into the electric arc give only the spectrum of the corresponding metal, but this is not the case with the fluorides of calcium, barium, and strontium. In this case, besides the spectrum of the metal, there is a brilliant band spectrum, which probably arises from the undecomposed fluoride. All the bands can be represented by equations of the form $N = B - Am^2$, in which N is the frequency, A and B constants, and m an integer.—The direct study of the transport of ultramicroscopic particles by the current: A. **Cotton** and H. **Mouton.** The motion of minute particles of colloidal silver has been studied under the microscope. Under the influence of an alternating current the particles are set in vibration, the period of which corresponds to the frequency of the alternating current.—The action of a magnetic field upon the n- and n_1-rays: Jean **Becquerel.** The action of the n- and n_1-rays upon feebly phosphorescent calcium sulphide is not produced when the bundle of rays passes through a magnetic field normal to the lines of force, but the action is transmitted without alteration parallel to the field.—An attempt at a photographic method for studying the action of the n-rays upon phosphorescence: E. **Rothé.** Owing to the difficulties experienced by many experimenters in obtaining definite results with a phosphorescent screen, it is obviously preferable to use an objective method if possible. An account is given of a photographic method.—Influence of the colour of luminous sources on their sensibility to the n-rays: C. **Gutton.** The sensibility of phosphorescent substances varies greatly with their colour. Calcium sulphide with violet phosphorescence is the most sensitive; the sulphides of the alkaline earths and sulphide of zinc, which possess a green phosphorescence, are less sensitive, and with sulphides possessing an orange phosphorescence no effect has been observed with the n-rays.—Remarks on a note of P. Villard on the magnetokathodic rays: H. **Pellat.**—On the electrostatic deviation of the magnetokathodic rays: Ch. **Fortin.**—The continuous registration of gaseous ionisation and of radio-activity by methods of loss of charge: Charles **Nordmann.** An electroscope is connected to the poles of a high voltage battery through a high resistance. Under the influence of the ionised gas the electroscope tends to lose a certain quantity per second, and this is balanced against the quantity coming in through the resistance from the battery. It is shown that the apparatus can be arranged to give the number of ions in the gas studied by a single reading.—On the properties of recently prepared gases: Eugène **Bloch.**—New researches on the cementation of ordinary and special steels: Léon **Guillet.**—On the production of isomorphous mixtures of lime and lithia: P. **Lebeau.** A mixture of the carbonates of lime and lithium decomposed by heat in a vacuum leaves a well crystallised residue of the mixed oxides, the composition of which depends on the temperature and duration of heating. The formation of mixed crystals of lime and lithia renders probable a cubic form for the latter substance.—The electrolytic separation of nickel and zinc: MM. **Hollard** and **Bertiaux.** In the presence of ammonium nitrate the nickel only is deposited. Experimental data are given showing that the separation is complete.—The alloys of magnesium with aluminium and antimony: Hector **Pécheux.**—The formation of dimethylisopropylcarbinol in the reduction of acetone: G. **Denigès.** In addition to isopropyl alcohol and pinacone, the usual reduction products obtained from acetone by reduction with sodium, the author has been able to isolate the above tertiary alcohol. The yield is small.—Syntheses in the pentamethylene series; the diamylene of pentane-diol: 1:5-diiodo- and dibromopentane: J. **Hamonet.**—The condensation of phenols and aromatic amines with benzylidene-aniline: Charles **Mayer.**—On the normal presence of formaldehyde in products of combustion and in smoke: A. **Trillat.** A small amount of formaldehyde is always formed in all combustions, even of hydrocarbons. The author regards this as a confirmation of the results of A. Levy and Henriet on the presence of traces of formaldehyde in atmospheric air.—Addition compounds of rosaniline salts; their dissociation, thermochemistry, and constitution: Jules **Schmidlin.**—Researches on the azo colouring matters derived from 2:2-dinaphthol: Emm. **Pozzi-Escot.**—On the existence of an oxidising-reducing diastase in plants, and the conditions of its action: J. E. **Abelous.**—On the classification of the Anthozoa: Louis **Roule.**—Parallel adaptation of the host and parasite under the same conditions of existence in certain Lepidoptera and their parasitic Diptera: J. Kunckel **d'Herculais.** —On the early state in some palms: C. L. **Gatin.**—On the geology of the neighbourhood of Barcelona, Spain: Jaime **Almera** and Jules **Bergeron.**—The Coal-measures in the north of Africa: Ed. **Bureau.**—The molecular weight of glycogen: Madame Z. **Gatin-Gruzewska.** The lowering of the melting point observed by Sabanejew for glycogen was due to the presence of impurities, since determinations on the purified substance give a scarcely appreciable lowering. The molecular weight of glycogen from these determinations cannot be lower than 140,000.—Studies on the action of maltase. Constancy of the ferment: influence of the products of the reaction: Mdlle. Ch. **Philoche.**—Contribution to the study of the formation and elimination of urea in man: H. **Labbé** and M. **Morchoisne.**—On the action of blood rendered hepatotoxic by intraperitoneal injections of the nucleoproteids of the liver: H. **Bierry** and André **Mayer.**—On the progressive ripening of cheese: M. **Lindet** and Louis **Ammann.**—Oceanography of the region of the Azores: M. **Thoulet.**

CONTENTS.

THURSDAY, JULY 7, 1904.

THE HARRIMAN ALASKA EXPEDITION.

Alaska. Vol. iii.—Glaciers and Glaciation. By G. K. Gilbert. Pp. 231; 18 plates and 106 text figures. Vol. iv.—Geology and Palæontology. By B. K. Emerson, C. Palache, W. H. Dall, E. O. Ulrich and F. H. Knowlton. Pp. 173; 32 plates and 18 text figures. (New York: Doubleday, Page and Co., 1904.)

IT is now nearly two years since we noticed in our pages (NATURE, vol. lxvi. p. 176) the two handsome volumes which were the first-fruits of the scientific holiday cruise in Alaska carried out in the summer of 1899 by a party of competent observers through the liberality of Mr. E. H. Harriman. Two further volumes of the series are now before us, one recording the observations made on glaciers and glaciation during the expedition, and the other dealing with the geology and palæontology of the places visited. Though necessarily of more restricted interest than the two first volumes, which dealt with general and varied topics, these books are scarcely one whit behind their predecessors as specimens of the printer's art, except in the matter of coloured plates. Profusely illustrated, well printed on good paper, and tastefully bound, it is evident that no expense has been spared in their production, and rarely do we find technical writings bedecked in such garb. The toned plates are beautifully reproduced, but the line drawings from photographs, which constitute most of the text figures, appear to have suffered to a certain extent from the very excellence of the paper, and would probably have shown to better advantage on the heavy smooth-surfaced product that we growl over so often in American books.

Neither volume is monographic for its subject, but while giving many references to previous literature and to data accumulated by foregoing explorers, deals mainly with the direct results of the expedition. In fact, the books are essentially a series of "papers" on the geology of Alaska, and the subject-matter is treated accordingly.

The first of these volumes (vol. iii. of the series) consists of observations on the glaciers visited by the party, and on the general glacial phenomena of the region, Mr. G. K. Gilbert acting as recorder in this subject. In his lucid descriptions of the existing glaciers and in his able discussion of some of the problems connected with their past history, Mr. Gilbert presents much that is of extreme interest to the glacialist, though the opportunities for personal study were mainly confined to the lower ends of glaciers that reach nearly or quite to tidal waters. In all cases, care is taken to give details and illustrations from dated photographs, so that future observers will be enabled to determine the movement of the ice-front. In many instances, past records were in existence which permit the modern changes in the length of the ice-rivers to be discussed. Curious discrepancies between the conditions in different parts of the country are recognised, for while some glaciers are in rapid retreat—*e.g.* the Muir, which when visited in 1899 was more than a mile and a half shorter than it was nineteen years previously—others had recently advanced.

"The most conspicuous fact brought out by the comparison of local histories is that they are dissimilar. Nevertheless, there are limited resemblances. The Glacier Bay and Disenchantment Bay histories agree in including a great retreat, occupying more than a century. The Port Wells and Grewingk histories agree in a moderate retreat occupying something less than a century. The La Perouse and Columbia histories agree in a present condition of maximum glaciation probably preceded by an important minimum" (p. 104).

The possible cause of these variations is discussed; and although no definite conclusion is reached, it is suggested "that the combination of a climatic change of a general character with local conditions of a varied character, may result in local glacier variations which are not only unequal but opposite" (p. 109).

The Columbia and La Perouse glaciers in their recent advance have invaded a mature forest-growth which had established itself near their margins. Most instructive to the glacial geologist are the illustrations and descriptions of the "push-moraines" of bouldery till full of crushed trees—in one case "not only tree trunks and branches but folds of peaty soil" (p. 77)—which, by a slight recent retreat of the ice, are left open to investigation along the devastated fringe of the forest. In looking at these pictures one might imagine that some gigantic wild boar had been uprooting the ground. Noteworthy, too, are the stream-built "waste plains" of coarse gravel which overspread the valley-floor in cases where the glacier does not reach quite to the sea, as described and illustrated in the instances of Hidden Glacier (p. 53) and Grewingk Glacier (p. 94).

It is mentioned that in 1899, soon after the visit of the expedition, Glacier Bay was choked up with floating ice, apparently due to the disintegration of the tidal ice-fronts by an earthquake shock. And since then, until the time of writing, it had been impossible for steamers to approach within several miles of the Muir Glacier.

The effect of ice-falls from the ends of tidal glaciers was observed to produce waves sufficient to erode the coast in places where wind-waves could not form; and it is suggested by Mr. Gilbert that we may thus explain the clear outlining of the shores of some glacial lakes the area of which seems to have been insufficient to produce important wind-waves.

In dealing with the Pleistocene glaciation (chapter ii.), Mr. Gilbert discusses the origin of the "hanging valleys" so abundant in this region, and accepts the view that the discordance of level between the trunk and tributary valley is in most cases due to the deeper glacial excavation of the main trough.

"It [the hanging valley] is a conspicuous earmark of the former presence of glaciers; and it helps to a conception of the magnitude of Pleistocene glacial erosion" (p. 115).

The grounds on which this assumption is based are fully stated and illustrated. Great stress is laid upon

the excavating action of ice by the process of "plucking," in which "blocks of bed-rock, being partly surrounded by the ice, are forced from their bearings and rolled or slidden forward" (p. 203). Evidences of marine submergence reaching up to at least 500 feet above present sea-level are described (p. 168), and it is surmised that local uplift may have taken place in the neighbourhood of the high mountains at a period later than the chief Pleistocene glaciation (p. 173).

The observations, admittedly scanty, on the coasts of Bering Sea, though indicating local glaciers of considerable magnitude, "seemed inconsistent with the theory of a continental glacier in the Bering Sea region" (p. 192).

The chapter (iii.) on "General Considerations as to Glaciers" formulates the elementary comparison between rivers of ice and rivers of water in the manner which American geologists have made customary. It contains also, among other suggestive matter, a novel discussion as to the effect of water in buoying up the ends of "tidal glaciers" when not deep enough to float them. The conclusion is reached "that there is no important difference, as respects pressure on the rock bed, between a glacier resting on the land and one which is partly bathed by the waters of a fiord" (p. 216), with the further significant deduction that the depth to which glacial troughs have been excavated is not demonstrative of a relatively low base-level at the time of their excavation (p. 217).

We have scanty space for the notice of the second of the volumes before us (vol. iv. of the series), which, however, is for the most part severely specialised. It consists of more or less independent contributions by several authors.

Prof. B. K. Emerson gives a general account of the geology of the places visited, with petrographical notes by Dr. C. Palache. The rocks described are mostly much altered by dynamic and thermal metamorphism, so that their age is often doubtful. They include old-looking gneiss, possibly pre-Cambrian; Carboniferous; Triassic or early Jurassic ("the Vancouver Series"); radiolarian chert perhaps Jurassic or early Cretaceous; and newer volcanic rocks.

Dr. C. Palache contributes some notes on the geology of the famous Alaska-Treadwell Mine of Douglas Island; a list of the minerals collected by the expedition; and a paper on the rocks of the neighbourhood of Chichagof Cove, in the Alaskan peninsula, where beds containing abundant fossils of Lower Eocene age were discovered, a period not previously recognised in Alaska. These fossils, which include our familiar *Venericardia planicosta,* are described and figured in a separate paper by Dr. W. H. Dall, who also describes some Pleistocene shells from Douglas Island.

Mr. E. O. Ulrich deals with the fossils of the Yakutat formation, which consist mainly of very curious casts, supposed to be fucoidal. A large number of these markings are named, described and figured, the beds containing them being assigned, on somewhat slender evidence, to early Jurassic, probably Liassic, times.

A collection of fossil plants of Upper Eocene age from Kukak Bay, on the Alaskan peninsula, forms the subject of the contribution by Mr. F. H. Knowlton, with which the volume closes. Of the twenty-six forms represented in this collection, nine are described as new to science.

G. W. L.

JOSEPH PRIESTLEY.

Memoirs of Dr. Joseph Priestley. Written by himself (to the Year 1795), with a Continuation to the Time of his Decease by his Son, Joseph Priestley. Reprinted from the Edition of 1809. Centenary Edition. Pp. 132. (London: H. R. Allenson, 1904.) Price 3*s.* net.

THE story of the origin and history of this little book may be told in a few words. The greater portion was composed by the subject of it in the year 1787, when at Birmingham as minister of the New Meeting. Priestley's tenure of this office was rudely interrupted by the shameful and disastrous riots of July, 1791, when his house and laboratory, and much of his apparatus and library, were destroyed by the mob. Although many of his books and papers were burnt or otherwise made away with, the autobiography escaped destruction, and was ultimately recovered. Some years afterwards, whilst at Northumberland, in Pennsylvania, whither he removed in 1794, he resumed the story of his life, bringing it down to March, 1795, when he had completed the sixty-second year of his age. Although he lived nine years more, for the most part in fairly good health, it would appear that he added nothing to his account of himself, and it was left to his eldest son to continue his biography to the time of his death, and to see the work through the press. The first edition of the "Memoirs" was published by Johnson, of St. Paul's Churchyard, a staunch friend of Priestley's, by whom, indeed, the greater number of his works—educational, theological, and scientific—were issued. It was reprinted in 1833, on the occasion of the centenary of his birth, and it is again reprinted in commemoration of the centenary of his death.

The present edition differs from its predecessors in several particulars. It is not quite so sumptuously printed as that of 1806. It resembles the edition of 1833 in containing illustrations. In the book before us, however, these are more numerous and more interesting, from the circumstance that the reader is enabled to see in some measure what manner of man physically Priestley was at various periods of his career. Unfortunately the illustrations hardly do justice to the originals, and as process reproductions leave much to be desired. The frontispiece is taken from a copy of Opie's well known portrait, now, we believe, in the Manchester College, Oxford. The second portrait is a poor and partial reproduction of Fuseli's picture, painted for Johnson, the publisher, and one of the very few portraits which that painter made directly from a sitter. The original work was a full-length figure, and is interesting as showing Priestley at the period of his greatest scientific activity. It is interesting, too, as affording material for the statue by Stephens in the Oxford Museum, of which we have a picture in the book. The third portrait is

by Artaud, a painter largely employed by the Nonconformists of his day, and represents Priestley as he appeared at the time of his leaving England for America. The last portrait is by an American artist, Stewart, and shows Priestley without his wig, and in the costume he adopted at Northumberland. We have in addition a reproduction of Williamson's statue erected in Birmingham, and unveiled by Huxley in 1874 on the occasion of the centenary of the discovery of oxygen. Lastly, there is a copy of Drury's fine statue which Leeds owes to the munificence and public spirit of Colonel Harding.

The Rev. Mr. Freeston, who is responsible for the issue of the present edition, is, no doubt, a great admirer of Priestley as one of the chief apostles of Nonconformity, as the sturdy champion of Unitarianism and the resolute defender of free inquiry and liberal thought, and this circumstance may account for the fact that, in his selection of the illustrations, the scientific side of Priestley's activity receives practically no recognition. Dr. Taylor, of Norwich, who became head of the Warrington Academy, was no doubt an eminent divine, but his connection with Priestley was of the slenderest. Dr. Andrew Kippis was of some assistance to him at times, especially in the earlier period of his career. Dr. Price, whom he succeeded at Hackney, and the Rev. Mr. Theophilus Lindsey were almost life-long friends, and no doubt exercised considerable influence on his fortunes. But so did Josiah Wedgwood, James Watt, whose association with Priestley gave rise to the famous Water Controversy, Matthew Boulton, Keir, Withering, and other members of the celebrated Lunar Society. There can be little doubt that Priestley's career as a natural philosopher, and, indeed, as a political writer and reformer, was largely the result of his connection with Franklin, for whom he had the greatest admiration and affection, and to whom considerable reference is made in the "Memoirs." Lord Shelburne, too, with whom Priestley spent some of the most fruitful years of his busy life, afforded him, in ample measure, time, money and opportunity for the prosecution of his work on pneumatic chemistry, and thereby contributed to lay the foundation upon which his fame largely rests. But although portraits of these persons are at least as accessible as those of the worthy Nonconformist divines mentioned above, and should, in all fitness, appear in any edition of Priestley's "Memoirs" in which portraits of his friends and co-workers are made a distinctive feature, they are conspicuous by their absence.

The reproduction of the view of Priestley's birthplace at Fieldhead, near Birstall, presumably made from Mr. Buckton's photograph, is interesting and pictorially unobjectionable, but that of the Nantwich Meeting House, where Priestley officiated for about three years, is simply hideous. The only thing that can be said in its favour is that it is at least as meritorious as the architectural character of the building it seeks to depict. Nor is the view of the Old Academy at Warrington much better. Priestley was, no doubt, familiar with the old building on the banks of the Mersey, although his connection with it was as slender as his association with its first head, Dr. John Taylor. Most of Priestley's life as a tutor at Warrington was spent in the New Academy, situated some distance from the building represented, and which, by the way, the author of the "History and Present State of Electricity" and of the "Essay on the First Principles of Government, and on the Nature of Political, Civil and Religious Liberty" would certainly not have recognised as here shown, mainly by reason of the imposing statue of the stalwart Cromwell and the large incandescent electric lamp which bulks so largely in the foreground. The fact is, the view represents the Old Academy as it exists to-day as the home of the Warrington Society, to the praiseworthy zeal and public spirit of which the old house has been rescued from the oblivion which was overtaking it.

We have no inclination to be hypercritical, but it is surely desirable that in the re-publication of a work which in its way may be reckoned as one of the classics of scientific biography, and is now brought out to commemorate the centenary of the death of its illustrious author, some effort should have been made to make the appearance of the book more worthy of its subject and of the occasion which has led to its re-issue.

T. E. THORPE.

A LADY ENTOMOLOGIST.

Eleanor Ormerod, LL.D., Economic Entomologist. Autobiography and Correspondence. Edited by Prof. Robert Wallace, Professor of Agriculture and Rural Economy in the University of Edinburgh. With portraits and illustrations. Pp. xx+348; plates xxx; text illustrations 76. (London: Murray, 1904.) Price 21*s.* net.

THE name of Eleanor Anne Ormerod will long be remembered for her unflagging industry and long-continued devotion to practical entomology, not surpassed in their own lines of research by Caroline Herschel and Mary Somerville, with whom she may most fittingly be compared. There can be no more fitting opportunity than the present to recall her services both to science and the world at large, when the Linnean Society (formerly so exclusive that ladies who contributed papers were not even admitted to be present when they were read) has just thrown open its full membership to women. The Entomological Society was never so exclusive; and at one time Miss E. A. Ormerod was one of the most regular attendants at the meetings, sometimes accompanied by her sister and fellow-worker, Georgiana E. Ormerod, and more rarely by some other lady friend.

By far the most interesting portion of this volume is the autobiography (occupying chapters i. ii., iv.–x.). Next in importance are chapter iii., by Miss Diana Latham, referring to Miss Ormerod's early life, and chapter xi. by the editor completing (all too briefly) the biographical sketch of Miss Ormerod's life. A very full account is given of her family, surroundings and education, with reminiscences of coaching days, the Chartist rising, and other matters which look like ancient history now, besides occasional geological and

archæological notes. Miss E. A. Ormerod was the youngest of a family of ten children, and was born on May 11, 1828, and she died after a long illness on July 19, 1901, after a busy and useful life, as happy, we may well believe, as that of Miss North or Miss Cobbe.

Natural history runs in families, and besides the two sisters, Eleanor and Georgiana, one of the brothers, Dr. E. L. Ormerod, has also left a worthy entomological record behind him in his valuable work on "British Social Wasps."

Among Miss Ormerod's accomplishments was a knowledge of Russian. It would have been interesting if we had been told how she came to study a language still so little known in England.

Miss Ormerod does not appear to have specially interested herself in entomology until 1852, and it was not until 1877 that she commenced the great series of reports of observations on injurious insects, the twenty-fourth and last of which was only issued in 1900, the year before her death, so that she may be said to have died in harness, though towards the end she found herself compelled by failing health gradually to decrease her entomological activities in other directions also. The most pleasing portrait of her in the book (taken from the oil painting in the University Court Room, Edinburgh) represents her in her University costume as the first woman hon. graduate of the University of Edinburgh, an honour as much to the University as to herself, and more gratifying to her than any other acknowledgment of her entomological work could have been. The title was conferred upon her on April 14, 1900. Her sister Georgiana predeceased her in 1896.

At the time when Miss Ormerod commenced her work in agricultural entomology much had been done by Westwood and Curtis to pave the way; but the few books on the subject were either costly or little known, and no popular interest was felt in the matter.

Miss Ormerod, however, by her reports, books and lectures, revolutionised all this, and effected a work equivalent to that of Riley in America, and the importance of agricultural entomology is now universally recognised, from the Government to the School Board. She was also a good practical meteorologist, and a fellow of the Royal Meteorological Society.

But it is much to be regretted that Miss Ormerod did not live to complete her autobiography on her own lines, and we cannot congratulate the editor on the manner in which he has performed his task. As he states in the preface, "Had the book been produced on the original plan, it was proposed to name it, 'Recollections of Changing Times.' It would have dealt with a number of subjects of general interest, such as the history of the Post Office, early records of floods and earthquakes, as well as newspapers of early date. The introduction of Miss Ormerod's letters to a few of her leading correspondents was made necessary by the lack of other suitable material. The present volume is still mainly the product of Miss Ormerod's pen, but with few exceptions general subjects have been eliminated, and it forms much more a record of her works and ways than it would have done had she been spared to complete it."

Surely at the present day specialism is so great, though so unavoidable, an evil, that the wilful elimination of everything but entomology from the chapters not actually written and edited by Miss Ormerod herself is equally unfair to herself and to her admirers. Had her correspondence been utilised with her reports to compile an abstract of entomological observations supplementary to those contained in her more permanent manuals the work might have been made a more worthy memorial of her; but instead of this two-thirds, at least, of the volume is composed of letters to various entomological correspondents without any sort of order or classification except by correspondents' names, and consists of disjointed observations on insects, and references to matters like the exchange of publications, of no real permanent interest or consequence, even to entomologists. Half-a-dozen letters selected to show Miss Ormerod's epistolary style would have been amply sufficient. The only interesting portions of this section of the work (except the few letters addressed, chiefly to the editor, on personal matters like the Edinburgh degree) are the numerous illustrations of insects reproduced from Miss Ormerod's reports, &c.

The early part of the work and the illustrations render the book useful and interesting; of the latter part we can only say that it is one of the most glaring instances we have ever seen (and we have seen sufficiently bad ones before) of how *not* to edit a biography.

SOCIAL CONDITION OF ANTHRACITE MINERS.

Anthracite Coal Communities. By Peter Roberts, Ph.D. Pp. xiii+387. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1904.) Price 15*s*. net.

THE great strike of 1902, which cost 20,000,000*l*. and led to the intervention of the President of the United States, induced Dr. Roberts to make an exhaustive study of the 630,000 persons deriving subsistence from the production of the anthracite collieries of Pennsylvania, and his book should be studied by all interested in the evolution of industrial society. The coalfields are situated in the north-eastern portion of Pennsylvania, and consist of scattered deposits of anthracite covering an area of 480 square miles. The mining population represents some twenty-six different races, one-half being Slavs. Anthracite mining is about eighty years old.

In the first fifty years of the development of the industry the United Kingdom and Germany furnished the labour required. During the past twenty-five years the Slav nations have done so. Immigration into the coalfields has now virtually ceased. The present population is amply sufficient to furnish the necessary labour for the maximum tonnage that the collieries can produce. Conditions in the industry are not such as to attract labour of a high grade, and the high birth-rate of the Slav population will more than supply the labour needed in an industry that will necessarily soon be declining.

The characteristics of the Slav population are depicted by the author in lurid colours. The Slavs are, he asserts, clumsy, ignorant, drunken, superstitious, unclean and brutal. At the same time the Slav nature is good material to work upon. As the Slav comes in contact with Anglo-Saxons and learns their ways, his wants are increased and his tastes refined. The unsavoury details of squalor and vice among the Slav miners are certainly not understated by the author, who has naturally no sympathy with the ideas and aspirations of a people who, by adhering to their language and customs, remain unassimilated after years of residence in the United States. Similar statements are often made regarding the Slav immigrants in the coalfields of Scotland and of Westphalia. Probably the Slav colliers of Pennyslvania are not more debased than the mining populations of many of the European coalfields. If they are, the responsibility must rest largely with the coalowners, who provide habitations where self-respect and decency are unattainable luxuries.

The author's gloomy views regarding the social condition of the anthracite communities cannot be accepted without reserve. They are certainly not in accord with the views of the Anthracite Coal Strike Commission, who found that the social conditions obtaining in the communities made up largely of coalworkers were good, and that the number and character of the schools accessible in all these communities were fully up to the American standard. The number of churches in proportion to the population was rather above the average, and the opportunities generally for instruction appeared to be adequate.

The work is illustrated by twenty-eight half-tone plates, most of which are excellent, and there is a long bibliography of works consulted. The quotations in French, being printed without accents, are difficult for the ordinary reader to understand, and in one quotation, "Ellis il font diaque nuit," it is not apparent what language is used. B. H. B.

OUR BOOK SHELF.

Elements of Water Bacteriology. By Samuel Cate Prescott and Charles-Edward Amory Winslow. Pp. x+162. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd.) Price 5s. 6d. net.

THIS little volume is practical in its conception, and is concise in treatment. It, of course, presupposes a sound knowledge of general bacteriological methods, but the authors have undoubtedly produced a manual for laboratory use which will be of value to all intelligently engaged in the examination of water. It is up to date in the various methods described, and thirty pages are devoted to a careful index of the contents, a list of memoirs referred to in the text, and the names of authors. Perhaps the most interesting feature in the book is the "change in front," so to speak, which it indicates some water-bacteriologists are making in regard to the relative importance of the presence of typhoid and colon bacilli respectively in water. A third of the letterpress is devoted to the *Bacillus coli communis*, its detection and its significance in water, whilst the typhoid bacillus, so long the *bête noire* of sanitarians, is disposed of in a few pages. The attitude of, at any rate, American authorities is effectively summed up in the following paragraph:—

"On the whole it seems that since a positive result is always open to serious doubt, and a negative result signifies nothing, the search for the typhoid bacillus itself, however desirable theoretically, cannot be regarded at present as generally profitable."

So, because the typhoid bacillus is difficult to find and the detection of specific organisms is being clamoured for in the estimation of the bacterial quality of a water, refuge is taken in the more easily discoverable and well-nigh ubiquitous colon bacillus, or its allied forms.

It will be interesting to watch the progress of opinion on this colon-standard of water-purity in the light which it is hoped further researches may be able to throw on the detection and significance of specific bacteria in water.

The Chemistry of Coke. By W. Carrick Anderson, M.A., D.Sc. Second edition. (Glasgow and Edinburgh: Hodge and Co., 1904.) Price 5s. net.

THIS little volume, which has reached its second edition, contains much practical information about the chemistry and chemical analysis of coal and coke which should be useful to scientific makers of coke.

But apart from its practical side, the book would justify its publication if it served the single purpose of showing how scientific method may be applied to the problems of a relatively simple industry. That different coals of the same composition, or *isomeric coals*, as the author calls them, behave quite differently on coking is well known. This must, of course, arise from the presence of different chemical constituents. Perhaps it would have been wiser to remain content with the statement (p. 64) that "so long as the composition of coal is unknown the peculiar internal reactions of coking will assuredly remain shrouded in obscurity" than to hazard the suggestion (p. 60) that "in coking, side-chains as well as the central part or radicle reacts."

The absence of any reference to the relation of composition to by-products seems a curious omission when, as the author himself says, "the manufacture of coke without recovery of by-products is to-day frequently regarded as scarcely any longer a payable industry."

The writer would like to offer the suggestion that a careful microscopic examination of coal, which has been found so useful in other directions, might lead to interesting information both as to coking qualities as well as the nature of the by-products of different varieties of coal. Perhaps this method of investigation has already been tried and found wanting. J. B. C.

Praktischer Leitfaden der Gewichtsanalyse. Zweite Auflage. By Paul Jannasch. Pp. xvi+450. (Leipzig: Veit and Co.) Price 8 marks.

A SECOND edition of Prof. Jannasch's well known book treating of gravimetric analysis has now appeared, and contains considerable additions of new matter. It is obvious, even from the most cursory examination, that the book differs from most of its class in that it is in no sense a compilation of old and often obsolete methods.

Prof. Jannasch is well known as the author of many new methods in analytical chemistry, and the results of his own work and that of his pupils have been made great use of in preparing the present volume.

The contents of the book are divided into nine sections, each of which deals with analyses of a particular type; thus, starting from the determination of the constituents of simple salts in the first, the second treats of the analysis of simple alloys, whilst the third, fourth, and fifth sections deal with the quantitative separation of the various metals one from another. By far the greater number of the processes recommended for these separations are those with which the author's name is connected, involving the use of hydrogen peroxide, hydroxylamine, and hydrazine,

The sixth and seventh sections contain instructions for mineral analysis, and one is struck by the very complete account given of methods by which the decomposition of the mineral is effected by heating in a current of gas, *e.g.* oxygen, hydrochloric acid, or bromine. The eighth section is taken up with silicate analysis, whilst the concluding section gives an account of the estimation and separation of the halogens and of many other analyses which do not naturally find a place in the earlier portions of the work.

Although it is clear that the author has taken great pains in the preparation of his book, it may be questioned as to whether the selection of exercises has been uniformly judicious, and as to whether the author's own processes do not occupy a too prominent position, so leading to the exclusion of standard methods of analysis with which every student should be familiar. For example, the author's process for the separation of manganese and zinc by means of hydrogen peroxide in alkaline solution, although found unsatisfactory by other investigators, is fully described to the practical exclusion of the more usual method. The same criticism applies to the larger proportion of the other "hydrogen peroxide separations" which here figure so largely. Again, in the section dealing with silicate analysis, the author's methods of decomposition, especially the one employing boric anhydride, are given at great length, whilst the ordinary method of alkali-carbonate fusion, which is constantly employed both in technical and scientific analyses, is given in a not very happily modified form, and in a subordinate position.

Although the book presents very many excellent features, and should, when used in conjunction with other works, be of great value, it is hardly considered likely that a student who derives his information solely from this source would possess a competent knowledge of the *general* methods of analytical chemistry.

H. D. D.

Practical Slide Making. By G. T. Harris, F.R.P.S. Pp. 134. (London: Iliffe and Sons, Ltd., 1904.) Price 1s. net.

NEARLY every photographer at some time or another makes his own lantern slides, and so numerous are the methods available, and so varied are the results that can be obtained, that another handbook on the subject is very welcome. In these pages the author successfully attempts to supply trustworthy information on the subject in a concise form, describing the best known methods for obtaining these transparencies. He lays stress on the great efficiency of some of the older processes, and with the hope that they may be revived he includes them in this book. The first two chapters deal with the apparatus for exposing the plate, and the remainder treat of the development by the several methods described, and of the various other manipulations required before the slide can be considered properly finished. No pains seem to have been spared to obtain accuracy in the formulæ and to render clear the methods of procedure, so that the book forms a trustworthy guide.

Botany Rambles. Part ii. *In the Summer.* By Ella Thomson. Pp. 130. (London: Horace Marshall and Son, 1904.) Price 1s.

THE young learners for whom this little book is intended are urged persistently to see for themselves, by examining plants, that what is told them in the lessons is true. They are instructed in simple language how to set about this work of verification and are urged to make use of their own eyes to find out additional facts for themselves. It is evident that the writer understands children and knows how to arrest their interested attention.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Exradio Spectrum.

FROM a private communication from Mr. Baxendall, I learn that he has noticed the following correspondences between the spectrum of the emanation from radium (exradio) and the spectra of "bright line stars" (Campbell, *Ast. and Ast. Phys.*, vol. xiii. p. 468):—

"Exradio."	Bright Line Stars (Campbell).
5805	5813
5595	5593*
4690	4688
4650	4652
4630	4633

With the exception of 5593*, these stellar lines are all strong and characteristic. Another of the exradio lines, 5137, may correspond with 5135.

I am very ignorant of stellar spectra, and send this note merely to direct attention to a possible correspondence.

University College. WILLIAM RAMSAY.

The Occurrence of Radium with Uranium.

A LITTLE time back, Mr. B. B. Boltwood published in this Journal (May 26, p. 80) a preliminary notice of an investigation of the ratio of uranium to radium in various minerals. I have for some time been engaged in a similar investigation, which, though the results are not yet matured, seems to be leading to the conclusion that this ratio is constant, as in Mr. Boltwood's experiments. An interesting case is the mineral torbernite, or copper uranite. This mineral forms transparent green tetragonal crystals the composition of which is accurately represented by the formula $CuO.2UO_3.P_2O_5.8H_2O$. The substance dissolves easily in sulphuric acid, forming a perfectly clear green solution. This solution, when boiled, gives the radium emanation, and the quantity of emanation produced in one day is about the same as that yielded by the same weight of Joachimsthal pitchblende. The percentage of uranium is also about the same. If the radium in this mineral has been produced since the formation of the mineral (and the recent quantitative experiments of Sir W. Ramsay and Mr. Soddy on the absolute rate of production of the emanation seem to make that certain), there is practically no choice as to what the parent substance should be. Uranium is the only candidate. The great complexity of most of the radio-active minerals may make it difficult to obtain conclusive evidence by studying them. But here there seems to be no alternative but to conclude that uranium is the parent. R. J. STRUTT.

Residual Affinity.

SIR OLIVER LODGE's highly suggestive letter (June 23, p. 176) will be welcome to the many chemists who have been endeavouring to interpret chemical phenomena in terms of the electronic theory of the physicist. The proposition that the "Faraday tube" may be subdivided would appear to be capable of being widely applied in connection with many of the most interesting phenomena of chemistry. Thus not only would the existence of water of crystallisation and the formation of so-called molecular compounds be thereby brought into line with the more typical manifestations of valency, as pointed out in Sir Oliver's letter, but it would appear that it may possibly enable the hitherto conflicting hydrate and dissociation theories of solution to be harmonised. Thus in the case of an electrolyte such as sodium chloride, we should in the dry state regard the sodium atom united to the chlorine atom by means of a Faraday tube or bundle, as it may more appropriately be designated, the union leading to the great stability of the compound as such. On the addition of water, however, some of the constituent fibres or strands of the bundle become deflected in such a way that the sodium

and chlorine atoms become respectively combined with water. With sufficient water present the original union between the sodium and chlorine atoms will become entirely severed, the Faraday bundle starting with its positive extremity on the sodium atom will terminate at its negative end *by means of a plurality of strands on a number of water molecules*, and similarly the Faraday bundle emanating by its negative extremity from the chlorine atom will terminate at its positive end in a plurality of strands also on a number of water molecules. In such a solution we should thus have independence of the sodium and chlorine atoms, or the phenomenon of ionisation. In such a solution, moreover, the union between sodium and chlorine would be entirely abolished through the complete diversion of the strands of the Faraday bundle formerly uniting them, whilst the union between the oxygen and hydrogen of the water molecules would be but slightly weakened owing to only a small fraction of the total number of strands in the bundles uniting the oxygen and hydrogen in each molecule being diverted by the sodium and the chlorine. The dissociation into its ions of an electrolyte on solution in water would thus be the consequence of the antecedent hydration of the ions.

Some of the colour changes attending the attachment of water of crystallisation may be interpreted in the same way. Thus anhydrous copper sulphate is colourless, whilst the crystallised salt containing five molecules of water is blue. The direct union of the copper atom by means of two Faraday bundles with the SO_4-group leads to the production of a colourless compound, whilst by the diversion of the strands of these bundles, through the attachment of five molecules of water, the copper atom and the SO_4-group become severed, and the blue colour characteristic of the copper ion makes its appearance.

According to this view solution should always be attended by the weakening of the union between at least one pair of bonds in the molecule of the solute owing to the diversion of at any rate some strands of the bundle or bundles, and such loosening is betrayed in the greater chemical reactivity of substances in solution.

Similarly in catalytic phenomena, the catalytic agent may be regarded as diverting some of the constituent strands of bundles, and the action of water in effecting ionisation, *i.e.* complete diversion of bundles, would thus appear as an extreme case of catalysis, leading to such an acceleration of the velocity of reaction between electrolytes that reactions between ionised electrolytes are practically instantaneous.

It is needless to say that this is merely a preliminary and very imperfect attempt to apply the electronic theory to a few of the most familiar and important chemical phenomena. Sir Oliver Lodge's suggestion with regard to the electrical interpretation of valency and bonds is indeed so luminous and stimulating that it should provoke the careful review of chemical facts by the light of this new conception of the possibility of an indefinite number of different grades of chemical union, of which the union by chemical bond, hitherto the only one generally recognised, is to be regarded merely as an extreme case.

Birmingham, June 27. PERCY F. FRANKLAND.

Science in the Common Examination for Entrance to Public Schools.

IN the interests of education, may I ask you to find room in your columns for the enclosed copy of the science paper recently set in the above examination? The average age of the candidates may be taken as about thirteen years. Comment is almost superfluous. The effect, whether intentional or not on the part of those who set the questions, of such an examination paper must be to discourage science in the preparatory schools. No boy of thirteen years of age could or should be expected to answer more than a very small portion of so advanced a paper. If headmasters of preparatory schools are led to imagine that this is the kind of thing that is expected of their pupils, in very despair they will be forced to abandon science entirely, and fall back upon its alternative in this examination—Latin verse.

This common examination has now been held for the first time, and it is important that an emphatic protest should be raised without delay. If the science paper is allowed to be of this unreasonable character, the subject will receive a set-back that will go far towards undoing all that has been tardily achieved during the last twenty years in regard to scientific teaching in our public schools.

OSWALD H. LATTER.

Charterhouse, Godalming, July 2.

June 29, 1904.—SEVENTH PAPER.
(Alternative with Latin Verse.)

COMMON EXAMINATION FOR ENTRANCE TO PUBLIC SCHOOLS.

SCIENCE.—(*One hour.*)

I.—*Physics.*

(1) A weight hangs by two strings each making an angle of 60° with the vertical. Show that the tension of each string is equal to the weight.

(2) A uniform rod 10 feet long and weighing 5 lb. is pivoted 3 feet from one end. A weight of 50 lb. is hung on the end nearer to the pivot. Find what weight must be hung on the opposite end to balance the rod.

(3) Gravity is often measured by the number 32. Explain this. A body is thrown up with a velocity of 48 f. s. In what time will it lose its velocity? In what time will it return to the hand? How high will it go?

(4) A rectangular vessel on a square base is filled with water. Find the relation between the height of the vessel and a side of the base in order that the fluid pressure on one vertical face may equal that on the base.

II.—*Botany.*

(1) Enumerate the floral whorls from outside inwards. Explain what is meant by cohesion and adhesion among floral organs. Make a careful drawing of the section through a flower in which petals and stamens adhere to the calyx tube. Name a flower in which you have observed this structure.

(2) A potato is often spoken of as a root. Is this correct? Give reasons. Name three other cases in which a similar error is made, explaining the real nature of the organ in question.

(3) Draw sections shown in cutting lengthwise through a bean (or acorn) and a grain of barley (or date stone). What difference would be observed during their early growth? Of what great divisions of plants are these characteristic respectively?

(4) What plants would you expect to find in flower in a damp wood on a clay soil in April? Describe one or more of them.

An Early Mercury Pump.

IT may interest some of your readers to know that as early as 1820 an air pump was described depending on the formation of a Torricellian vacuum, and therefore on the same principle as Geissler's and its successors. The paper is by M. Fafchamps—"Description d'une machine pneumatique à l'aide de laquelle on opère le vide sans le secours de la pompe" (*Annales générales des Sciences physiques*, Bruxelles, vol. vi., 1820, pp. 101–2).

A vertical tube standing in a trough is provided with a stop-cock near its upper end. The tube above the stop-cock has a reservoir at the top, and on each side is a stop-cock, one connected with the vessel to be exhausted and the other to a large funnel. The upper end of the reservoir is also provided with a stop-cock. To work the machine the reservoir is first filled with mercury or some other liquid which is introduced through the funnel, the air being expelled through the stop-cock at the top of the reservoir. When filled with liquid the stop-cock of the reservoir is closed, and communication with the funnel is cut off. The stop-cock on the tube is now opened, when a Torricellian vacuum is produced in the reservoir; on opening the cock connected with the receiver air is withdrawn, and so on.

The author remarks that if mercury is used, the vertical tube must be 758 mm. long; if water, the tube must be more than 10 metres, but the length of the tube may be reduced by diminishing the atmospheric pressure on the

surface of the liquid in the trough below. He also remarks that a machine could be devised which would pump up the liquid and open the stop-cocks at the proper times, and thus make the action continuous.

The paper is illustrated.

July 1. HERBERT McLEOD.

HATS AND HAIR.

PUBLIC attention has been recently directed to the head-gear of civilised man, which, it is held, is neither necessary nor advantageous. We have here one of the attempts of well-meaning reformers to regulate on rational principles the dress of man, and so to assist him in his work of self-adaptation to his surroundings and needs. The object is laudable, and in all probability the scientific truth is with the reformers, but it may be well to review the question on somewhat broad lines.

The scalp is unique among the areas of the human body where hair is abundant, for there has been a notable development of hair in both sexes in this region beyond what can have existed in any of the Anthropoidea that can be placed in the human family tree. This is the more remarkable because man's pelage is a degenerating and disappearing character, except in a few areas. We must assume that when primitive man was in the making, natural selection led to the growth of thick hairy covering on his head which conduced to success in the struggle of life by protection against excessive heat and cold, against rain, and against minor injuries. As he advanced from his ancestral arboreal home into the open, and the range of his life extended, such natural adverse influences as these would call forth useful adaptive modifications, such as increased thickness and length of hair. At a later stage his developing intelligence would bring the same character under the influence of sexual or physiological selection, and this would strongly supplement the earlier factor of natural selection. Between these two factors a very stable character of the race has been produced.

There is considerable evidence that in spite of the stability of this character, the vigour of the hair on the head of man, especially in the male sex, is declining. The complexity of the conditions of civilised life renders it impossible to prove that this is due to the cessation of natural selection and the inability of sexual selection to arrest decline, but it is highly probable that this is the case. The more immediate question is this—is a decline in the growth of hair part of a general degeneration of man's ancestral pelage, or is it due to some factor introduced by man himself? It is declared by the reformers that the wearing of head-gear is responsible for the increase of premature baldness. Hitherto the discussion of the question has consisted of little more than individual opinions and *ex-parte* statements, and it is doubtful if evidence can prove or disprove the doctrine now being advanced. Experiment is, from the nature of the case, out of the question, because of the length of time required and the general complexity of the problem. It would seem that the nearest approach to a solution must rest on analogies derived from other characters of man himself and from the lower animals. The study of adaptive modifications (the "modifications" of Lloyd-Morgan and the "ontogenic variations" of Osborn) shows that they thrive when exposed to the natural conditions amongst which they arose, so long as these do not become excessive.

The wearing of coverings for the head affects the hair which is covered in three ways—the natural forces of sunlight, free ventilation, and movement from wind are prevented, the arteries which supply the skin of the scalp and nourish the hair-follicles are compressed, and nutrition thereby diminished, and the head-dress affords a culture-ground for micro-organisms, being also itself impregnated with them. The absence for the time being of the germicidal effect of the sun's rays and of movement of air, and the warmth and moisture of the contained air are just those conditions which would be chosen for the culture of these low vegetable organisms. Very much of the premature baldness of men is due to dandriff (*Seborrhoea sicca capillitii*), a disorder of the sebaceous glands characterised by excessive secretion of sebum and its accumulation in crusts with an admixture of epithelial débris, which leads to destruction of the hair-bulbs, and this disease is essentially microbic in origin. From these various points of view it seems to be indicated that the wearing of coverings for the head slowly diminishes the vigour of the hair. If this theoretical side of the matter cannot be demonstrated, but is only extremely probable, the practical outcome of it is no less beset with difficulties. A change of custom, if desirable at all, is less called for in the case of women than of men, for in the former the head-gear is mostly of light texture and covers a very small portion of the vertex, at any rate in modern times, and a much larger surface is left exposed to sunlight and air than in the case of men. In addition to this fact it is to be remembered that the evidence for decline in the growth of hair is much less in women than in men. Those whom the practical matter chiefly concerns are children of both sexes, young adults, and all male adults, and to these the reformers speak from a sound physiological basis. Whether or not their advice will be taken, or ignored as a counsel of perfection, remains to be seen, and the change advocated is certain to be the occasion of extravagant partisanship.

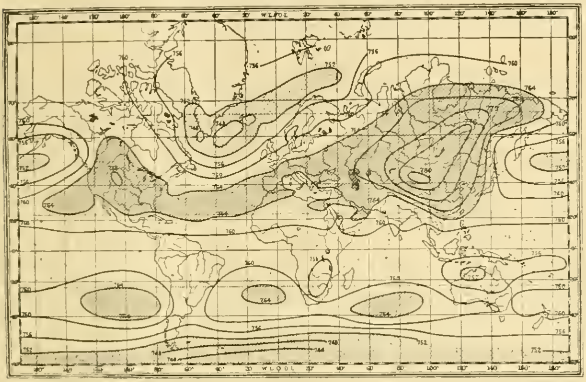
Certain objections to it may be anticipated and removed. First, it will be declared to produce "colds." It is most unfortunate that this name is given to what modern medicine calls "catarrh." The belief that "colds" are produced by exposure to draughts or cold winds is dying hard, and is fortified by the old name so long applied to them, but it is to stultify the great teachings of bacteriology to invoke some casual draught as the cause of disorders of which a nasal catarrh is a type. This danger may be entirely disregarded. It would indeed be for the benefit of the public in more ways than one if they became imbued with the knowledge that pathogenic bacteria of some undetermined species are the efficient cause of all catarrhs. Secondly, it may be feared that inflammatory complaints, such as neuritis or "rheumatism" in the head, would arise from uncovering the head. This is highly improbable considering how large a surface of the head is always uncovered, and that there is no greater protection from hair in the parts uncovered than there is on the vertex. Thirdly, there is undoubtedly some danger, even in temperate climates, from exposure of the head to great sun-heat, and against this danger special precautions are and always would be taken. Fourthly, there is the danger from septic organic matter in towns. This can hardly be reckoned as important, for the area which is necessarily exposed to it is considerable, and proper hygiene of the hair would render it unimportant. Fifthly, injury to the texture of the hair from heat and cold winds is feared, and this again is negligible in view of the fact that the already uncovered parts of the head are better provided with vigorous hair than the covered parts.

Whether the reformers have scientific truth on their side or not, it is possible that the æsthetic aspect of the matter will prove the stronger.

THE MECHANICS OF THE ATMOSPHERE.[1]

THE motion of the atmosphere at any time is admitted to be so complicated that any approach to a workable representation of it must necessarily be by steps. The motion at any time must be regarded as a temporary divergence from the average motion, and the question naturally arises, What is the nature of the average state of motion about which the

FIGURE 1. SURFACE ISOBARS FOR JANUARY. REPRODUCED FROM HANN'S "METEOROLOGIE."

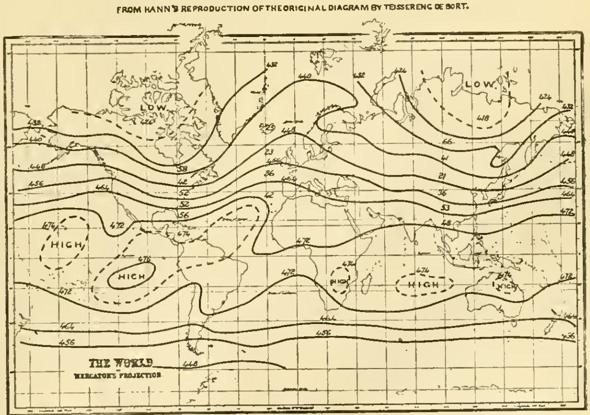


actual state of motion fluctuates? We may approach the solution of this question in either of two ways; we may find out what the motion actually is or we may find what the forces are which, so far as we can tell, cause the motion, and trust to our knowledge of dynamics to compute the average motion from the average forces. As regards the latter method, it may be said that the dynamics of an elastic fluid moving on a rotating spheroid, however interesting, is beset with an extraordinary number of temptations to error, and the more humble ambition of trying to find out what the motion really is, although painfully laborious, has advantages which may be compared with the advantages which walking has as compared with the use of a flying machine.

In the early 'seventies of the last century, Clerk Maxwell set a question in a Cambridge examination to which I owe the inspiration of a number of lectures and examination questions. It was this:—"Show how by observations of the motion of a body the resultant force acting upon it may be determined," and he added the luminous rider (I quote from memory), "A fish weighing 10 lb. swims through the water with a uniform velocity of 10 miles per hour, always in the same direction; find the resultant action of the water on the fish." As soon as one begins to think of answering these questions, and in particular of applying them to the relation between the controlling forces of pressure and the motion of the atmosphere, one realises what pitfalls await the unwary. The most obvious remark in relation to the first question is that the motion at any instant tells us absolutely nothing whatever about the forces acting. Unless observations sufficient to determine the change of motion have been dealt with, nothing about the cause of motion is known. Yet, in spite of this rudimentary fact of dynamics, obvious enough when it is stated, I cannot help wondering how many students of elementary dynamics ever really get rid of the notion that if you find a body moving in a certain direction you must look for a force in that direction too; we are surrounded with examples to the contrary, but the study of dynamics, being mainly deductive, usually passes them by.

In meteorology it is impossible to avoid the consciousness of temptation to the converse error of expecting to find the motion of air in the direction of the recognised forces. The most obvious force is that due to pressure, and who can resist the temptation of thinking that the flow of air from a high-pressure area to a low-pressure area must be the dominant feature of atmospheric motion? Yet the one great inductive statement in connection with meteorology, Buys Ballot's law, warns us that if we trust to the direction of forces to indicate the direction of motion we shall certainly be misled. Motion along isobars, perpendicular to the gradient, is a closer representation of the actual state of things than motion along the gradient, along, that is to say, the direction of resultant forces.

FIGURE 2. ISOBARS AT THE LEVEL OF 4000 METRES FOR JANUARY. FROM HANN'S REPRODUCTION OF THE ORIGINAL DIAGRAM BY TEISSERENC DE BORT.



Pressures in millimetres: velocities in miles per hour, corresponding to the acceleration for different gradients resulting from the Earth's rotation.

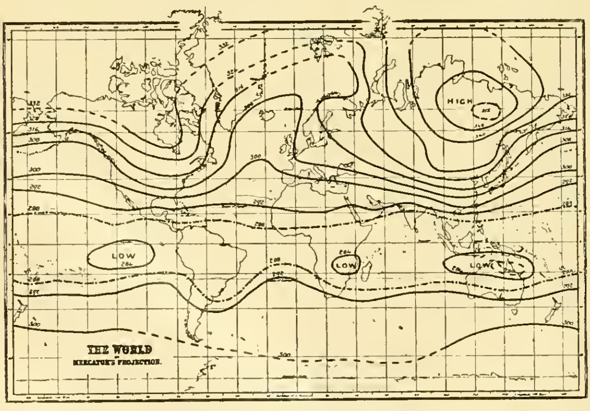
There is no doubt that if we could arrest for a time the motion of the atmosphere, without altering the pressure, and let the air start again from rest, the direction of initial motion would be along the pressure gradients from high to low, but we have to deal with an atmosphere that has been moving for countless ages, and all that existing forces do is to maintain or disturb the average, or steady motion; if in those

[1] Based upon a paper on the "General Circulation of the Atmosphere in Middle and Higher Latitudes," read before the Royal Society on June 2 by Dr. W. N. Shaw, F.R.S.

circumstances we find the motion taking place in the direction of the forces, we find a condition of things which ought not to be expected, and one which requires explanation.

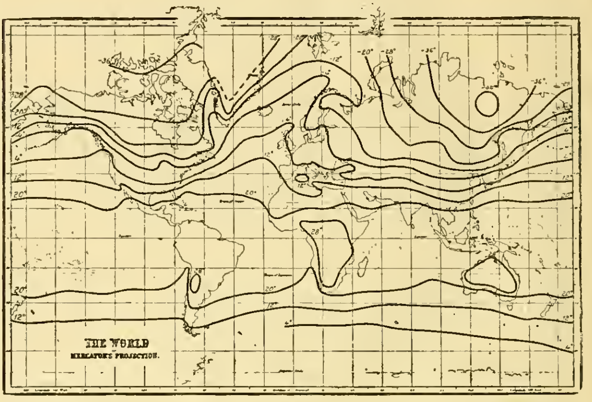
The question arises as to what one ought to expect the steady motion to have become in course of time. To afford some idea of the answer to this question, let me refer to the four diagrams here reproduced. The first gives the average isobars for January at the earth's surface, and discloses no simple representation of steady conditions. There are the well known high-pressure areas about the tropics, and isolated regions of low pressure over the North Atlantic and Pacific; but when we look at Fig. 2, the isobars computed by Teisserenc de Bort for the 4000-metre level, there is an indication of comparatively simple steady motion, namely, a motion round the polar axis from west to east, somewhat deviated, however, to south or north by land or sea areas. Now if we assume that the motion is along the isobars thus represented, so that the lines of the diagram practically represent lines of flow of air, we must remember that the motion on a rotating earth implies a certain normal acceleration of the air to keep it in its path, just as the bob of a conical pendulum requires an acceleration towards its equilibrium position to maintain its motion in a circular path. The effective horizontal acceleration of the air is $2\omega V \sin \lambda$, where ω is the angular velocity of the earth, V the velocity of the wind, and λ the latitude.

FIGURE 3. MEAN PRESSURE DUE TO THE WEIGHT OF THE STRATUM OF THE ATMOSPHERE BELOW 4000 METRES. FOR THE MONTH OF JANUARY. COMPUTED FROM FIGURES 1 AND 2. PRESSURES ARE GIVEN IN MILLIMETRES.



Of the velocity at the 4000-metre level we can only form an idea from the observed motion of clouds, and, so far as we know, the only forces available to give the necessary acceleration are those due to the pressure distribution which Teisserenc de Bort has plotted. By equating the pressure gradient to the product of the density and acceleration we can determine V, and the values thus computed are shown in miles per hour by figures between the isobars on the diagram. They must not be confused with the pressures, which are given in millimetres. The average wind velocities thus computed are not at all unreasonable, and it follows that motion along Teisserenc de Bort's isobars at about 50 miles per hour is not at all an unreasonable representation of the average steady motion of the atmosphere at that level in the month of January. That the directions of motion are appropriate is confirmed by Hildebrandsson's report on cloud motion to the International Meteorological Committee.

FIGURE 4. MEAN TEMPERATURE AT THE EARTH'S SURFACE. FOR THE MONTH OF JANUARY. IN CENTIGRADE DEGREES.



So much for the upper air; the motion is comparatively simple. Then it might be supposed that the complexity of the surface motion is due to extreme complexity of pressure in the lower stratum. The pressure due to the weight of the lower stratum is shown in Fig. 3, which gives the pressure differences between Figs. 1 and 2. There is, strange to say, no more complexity about this distribution than there is about the pressure of the upper layer; in fact, the lines of the two are extraordinarily similar, only the pressure gradients run in opposite directions. Writing "high" for "low," the one diagram would not be an unsatisfactory duplicate of the other, except that the lower stratum has a dislocation of the pole of high pressure from the geographical pole to north-eastern Siberia. Applying the same principle of motion to this diagram as to Fig. 2, it would represent, with suitable velocities calculated in a similar manner, a circulation from east to west in each hemisphere round the pole of cold.

Compare both these diagrams with Fig. 4, representing the surface isothermal lines—the similarity is again conspicuous. The intervals are for every 8° C. of temperature instead of 8 mm. of pressure, and speaking broadly of the temperate latitudes, starting

from a suitable datum temperature or pressure, the lines might be interchanged, a step of one degree of temperature (Fig. 4) corresponding to a step of one millimetre of pressure in the same direction for the upper layer (Fig. 2), and in the opposite direction for the lower layer (Fig. 3).

The complexity of the surface pressure arises, therefore, not from the upper layer alone, nor from the lower layer alone, but from the superposition of the two. We can resolve the surface pressure into two components, one due to the upper stratum above 4000 metres which, if it acted alone, would produce a general circulation from west to east around minima of pressure near the poles; the other, due to the lower stratum, which, if it acted alone, would produce a circulation from east to west. Both circulations would correspond closely with the surface distribution of isotherms. Where the one is predominant, in the lower middle latitudes, we get resultant westerly circulation; where the other is predominant, near the poles of cold, we get an easterly circulation. Between the two we get a region of minimum pressure and a merging of the two circulations which gives rise to the circular storms of the northern and southern temperate zones.

It appears, therefore, that we ought to regard the surface distribution of temperature as giving rise to a distribution of pressure in the lower stratum tending to maintain a circulation of air from east to west round the poles of cold. Extending this idea, a region of cold in the northern hemisphere should tend to maintain a clockwise circulation round its centre in the lower atmosphere, and a region of heat a counter-clockwise circulation.

The reciprocity between the pressure distribution of the upper and lower layers is of course not fortuitous. Hann has shown that the expansion of the lower layer by heat increases the pressure at a given level in the upper regions, without altering the pressure at the surface, by the mere thrusting of part of the air upwards; so that the observed effect of expansion over a large area is to diminish the pressure of the lower stratum and increase, by an equal amount, that of the upper. Referring to the diagrams again, the effect of increased surface temperature upon the isobars of Fig. 3 would be a bulge of the isobars towards the region of low pressure—the equatorial regions; upon the upper isobars there would be a corresponding bulge towards the region of higher pressure, again the equatorial regions. Thus the lines of both diagrams would be affected geographically in an exactly similar way and to the same extent; they would thus preserve their similarity in spite of temperature variations at the surface.

It would be interesting to consider what the effect of the daily solarisation of the earth should be from this point of view. Primarily it should produce no pressure variation at the surface; but inequalities of motion in the upper and lower air would probably alter the relative phase or magnitude of the disturbance of the two components, and hence give rise to daily variations of pressure at the surface, and thus necessarily produce a diurnal variation of the barometer.

Other consequences follow from the treatment of the distribution of pressure due to the weight of the lower layer as producing, or rather maintaining, a circulation in the one direction or the other about the colder or warmer regions, as the case may be, instead of flow from cold regions to hot.

One important result as regards the formation of circular storms in our latitudes may be inferred from this method of analysing the distribution of surface pressure. Friends have frequently suggested to me that our circular storms are like the eddies formed when water flows through a bridge; and to them I have always put the question, What in the atmosphere stands for the bridge? I am now prepared to recognise that the caps of relatively cold air in the north and south polar regions form an adequate representation of the piers of the bridge. In the lower air, where the pressures of the polar caps are dominant, they stop the westerly currents which still flow in lower latitudes, and replace them by currents from the east. Between these two currents is a field where mixing must take place, and circular eddies may be formed.

What happens in the equatorial regions is another story. Buys Ballot's law shows that the equator is subject to a peculiar meteorological condition. If you stand with your back to the wind north of the equator, the low barometer is on your left; south of the equator, it is on your right. There must be a transition region where the law ceases to apply, as, indeed, one would expect if Buys Ballot's law is the practical expression of motion with an acceleration due to the rotation of the earth, and varying as the sine of the latitude.

In the upper air of the equatorial regions there is probably a persistent flow from the east, as shown by observations of clouds and of the Krakatoa dust. In respect of the formation of eddies, this current will act like an intermediate pier of a bridge. Hence, in January, the river in which, upon this analogy, atmospheric eddies may be expected is a stream of air flowing round the earth in middle latitudes, divided by the equatorial belt with its region of doldrums below and easterly current above, and bounded north and south by easterly currents which correspond with the circulation of the lower atmosphere induced by the predominant influence of the polar caps of cold air. Eddies may be looked for between the easterly and westerly currents, and they are sometimes found there.

W. N. SHAW.

NOTES.

THE trustees of the Carnegie Institution met on May 18 and transacted the necessary business to provide for the transfer of all matters to the Carnegie Institution of Washington, a charter for which passed Congress and was approved on April 28. The trustees named in the Act met at once and reorganised under the new charter. The by-laws of the Carnegie Institution were adopted as the by-laws of the new organisation, and the officers of the old organisation were elected. General resolutions adopting all the obligations, &c., of the old institution were passed. Under the new charter no questions can be raised as to the competency of the institution to carry on the operations outlined in the deed of gift of the founder. The executive committee of the Carnegie Institution of Washington met after the reorganisation, and practically completed the making of grants for the year 1904. It will greatly facilitate the work of the executive committee if all those thinking of making applications for grants for 1905 will do so not later than September, as applications for grants for 1905 will then be taken up.

A SLIGHT but decided earthquake, which lasted about a second, was experienced at Derby at 3.22 p.m. on July 3. The vibration was not nearly so pronounced as on the occasion of the seismic disturbance a year ago. A similar shock was felt in the mid-Cheshire district about the same time. In Leftwich, near Northwich, the tremors were very distinct. The shock, which was also felt in Northwich, lasted two seconds, and at Sandbach four seconds. Two shocks

were felt in Sheffield and the surrounding district. The tremor was from west to east. At Matlock Bath there were shocks running from north-east to south-west. The tremor appears to have been felt almost simultaneously throughout Derbyshire, south Yorkshire, Cheshire, and Staffordshire. Writing from Leek, Staffs, Mr. G. H. Martyn says the disturbance occurred there at 3h. 22½m. ± 1m. p.m. "It seemed to be a succession of about a dozen shocks in three seconds. The shocks increased to a maximum at about the third, and then diminished until imperceptible." Dr. Davison found a very slight record of the disturbance upon his seismometer at Birmingham.

THE death is announced of Prof. T. Bredichin, formerly director of the Pulkowa Observatory.

THE Vienna Academy of Sciences has awarded its Baumgarten prize, of the value of about 160*l.*, to Prof. Walter Kaufmann, for his investigations on the theory of electrons.

THE first meeting of the trustees of the Percy Sladen fund for the assistance of scientific research (see p. 182) was held at the Linnean Society last week. The trustees will not meet for the consideration of the first applications before November next, and such applications should be addressed to the clerk to the trustees of the Percy Sladen Memorial Fund, care of the Linnean Society, Burlington House, London, W., by the 1st of that month.

THE Congress of the Royal Institute of Public Health will be held at Folkestone on July 21–26, the Earl of Radnor presiding. In the preventive medicine section, Dr. Nash, medical officer of health, Southend, will open a discussion on a clean milk supply. In the section of bacteriology, Dr. Klein, the president, will give an address on the aim and scope of bacteriological analyses of water and shell-fish with reference to sewage pollution, and the report of a committee appointed to inquire into the methods of bacteriological analysis of water will be presented by Prof. Hewlett. Valuable papers and discussions are promised in the other sections—engineering, child study, and tropical medicine.

AT the second annual general meeting of the fellows of the British Academy, held on June 29, Lord Reay was re-elected president, and the following corresponding fellows were elected, this being the first occasion on which such fellows have been elected:—Count Ugo Balzani, Prof. H. Diels, M. le Comte de Franqueville, Prof. M. J. de Goeje, Prof. I. Goldziher, Prof. T. Gomperz, Prof. J. L. Heiberg, Prof. K. Krumbacher, Prof. F. Leo, M. Paul Meyer, M. Georges Perrot, M. Georges Picot, and Prof. C. H. Salemann. Sir Richard Jebb read a paper on Bacchylides, dealing chiefly with three topics—the illustrations of his mythology supplied by ancient art, the traces of earlier or contemporary literature in his poems, and his relation to Pindar.

A BANQUET was given to Mr. Chamberlain on June 30 by the Royal Institute of Public Health, in recognition of his services to preventive and tropical medicine. In acknowledging the honour, Mr. Chamberlain referred to the progress made in recent years in medicine and surgery. He remarked in the course of his speech that the light which had been thrown on the origin of disease justified the belief that "we are on the eve of great discoveries which will relieve the human race from some of the greatest scourges which have affected it. Now, at any rate, the importance of securing healthy conditions of life is recognised by everybody who cares for the welfare of his fellow-creatures. Preventable disease, at this moment, is, as we all know, a great agent for filling our workhouses, for raising our taxes, for weakening the fibre of the people, for preventing us from competing successfully in that eternal struggle for existence which must go on as long as the world shall last. In peace it is of the utmost importance, in war the same cause destroys more of our soldiers than the bullets or the swords of the enemy, and meanwhile the administration of the Army is lessened in efficiency by the preventable disease to which the agents of the Empire are constantly subject. It is to the efforts of men like Sir Patrick Manson, Major Ross, Prof. Haffkine, and others who have been devoting their time and atention to tropical medicine, to research into the causes of tropical disease, with the remedies for those diseases—it is to that branch of the science that my attention is chiefly directed."

DURING a recent expedition under the auspices of the Geographical Society of Baltimore for the purpose of making scientific researches in the Bahamas, Mr. O. L. Fassig made some interesting experiments with kites at Nassau, one of which was made from a steamer hired for the purpose. The ascents were made in the early part of July, 1903, and the results are published, with diagrams, in the *Monthly Weather Review* for December last. From an average of four ascents and seventy observations, there was a decrease of 1° F. for each 100 feet of elevation up to an altitude of 500 feet; from 500 feet to 1000 feet the decrease was 1° in 143 feet; from 1000 feet to 1500 feet 1° in 167 feet; between 1500 feet and 4000 feet the average decrease was 1° for each 191 feet of elevation. As regards relative humidity, there was a steady increase from the surface (73 per cent.) up to 4000 feet (96 per cent.), with the exception of a small drop near the 3000-feet level; this drop was probably due to an excessive value caused by the kite passing through clouds just below the 2500-feet level on several occasions.

WE have received from Mr. H. Arctowski, a member of the Belgian Antarctic Expedition, a summary of the meteorological results made on board the *Belgica* during its detention in the pack-ice. The paper in question is an excerpt from the *Annuaire météorologique* of the Brussels Observatory for 1904; the volume containing the hourly meteorological observations is now in the press; five memoirs dealing with other special matters have already been published. The *Belgica* entered the "pack" on February 28, 1898, and left it on March 14, 1899; during this period the ship was drifting over an area about the size of the Kara Sea. The author has discussed the daily and monthly means of the observations during a year, as if they were made at one fixed point; the results, therefore, can only be taken as approximately correct. The mean temperature of the year was 14°·7 F., maximum 36°·5 on December 27, minimum −45°·6 on September 8. The diurnal variation was notably different in the several months; grouping the three summer months together (December to February), the amplitude of the variation was 3°·8, while in winter (June to August) it was only 1°·1; in November it amounted to 8°·5. The amount of precipitation is not given; snow fell on 260 days and rain on 20 days. Between March and September auroræ were observed on 61 occasions; the phenomenon was last seen during the night of March 12–13, 1899. Fog or mist was observed on 261 days.

WE have received two important papers dealing with extensions of the theory of Bessel's functions. One is by Prof. C. Cailler, in the *Mémoires* of the Geneva Physical and Natural History Society (xxxiv., 4), and contains an application of the operation designated by M. Schlesinger as Laplace's transformation; the other is a con-

tribution by the Rev. F. H. Jackson, of H.M.S. *Irresistible*, to the Edinburgh *Transactions* (xli., 1), and deals with generalisations of certain expansions in terms of Bessel functions.

IN the *Atti* (xxxvi., 2) of the College of Engineers of Milan, Dr. G. Finzi and Dr. Nicola Soldati describe some interesting experiments on the resistance of bodies moving through air, which should have an important application to the problem of aërial navigation. The chief point of interest consists in the application of the so-called "manometric" method as opposed to the ordinary "dynamometric" method, whereby the present writers have determined the pressure at different points of planes, aërocurves, cylinders and spheres, instead of merely measuring the intensity of the resultant thrusts. For determinations of the variations in the position of the line of action and centre of pressure, such calculations should be of great value, and it is largely in these determinations that the solution of every problem in aërial navigation must lie. A gold medal has been awarded to the authors.

THE March number of the *Mémoires* of the Physical and Natural History Society of Geneva contains a general report of the work of the society for 1903 drawn up by the president, M. Paul van Berchem. The society has completed a new agreement with the municipal authorities, superseding the old agreement of 1855, which will afford the members additional facilities for the use of the town library, in which the publications of the society are deposited. Obituary notices are given of M. Alphonse Pictet, the traveller; of M. Théodor von Heldreich, the botanist; and of M. Théodore de Saussure. Profs. René Blondlot (Nancy) and Walther Spring (Liège) have been elected honorary members, and the *Mémoires* include an important paper by Marc Micheli on the Leguminosæ collected in the Mexican States by Eugène Langlassé.

WE have to acknowledge the receipt of three fasciculi (Nos. 1376–8) of the *Proceedings* of the U.S. National Museum. In the first of these Mr. H. G. Dyar catalogues the Lepidoptera of the Kootenai district of British Columbia, while in the second Messrs. Jordan and Snyder publish notes on fishes collected in Oahu and Laysan Islands, of the Hawaii group, with descriptions of new species.

IN the *Atlantic Monthly* for June, Mr. T. C. Smith records the results of his efforts to reproduce in musical notation the song of the various local phases of the American bird commonly known as the wood-thrush. The score will not enable the musician to reproduce the actual timbre of the song, all that it attempts being to symbolise roughly the tones of the musical scale to which the notes of the bird approximate.

THE Hon. Walter Rothschild has presented to the British (Natural History) Museum a female of the basking shark (*Cetorhinus*, or *Selache*, *maximus*) from Bergen, which has been set up by Messrs. Brazenor Brothers, of Brighton, and measures 26½ feet in length. The new specimen has replaced the male which has for some years been exhibited in the fish gallery, and is now somewhat the worse for wear. The male measures 28 feet, and is mounted with the mouth open, while Mr. Rothschild's specimen is shown with the jaws closed.

THE *Field-Naturalists' Quarterly* for June is a good number, containing interesting articles on British social wasps, protective coloration in plumage, and on the means of recognising our commoner birds. Mr. Aflalo also contributes a paper on south coast museums, which, if a little wide of the scope of the journal, conveys some useful information on their contents. The editor takes occasion to urge that in future the British Association should assign either a day in each of the sections devoted to subjects in which the field-naturalist is interested, or a special section to field natural history.

BIRMINGHAM University has issued an exhaustive report, by Mr. W. E. Collinge, on the "big-bud" disease which of late years has played such havoc among black-currant bushes in this country. The disease is produced by the black-currant gall-mite (*Eriophyes ribis*), the larvæ of which display unrivalled powers of spreading themselves over plantations. Although some success has attended the use of soap and sulphur spray, the author is of opinion that growers must rely largely on the aid of natural enemies of the pest, or on root and branch extermination of the affected bushes.

THE *Zoologist* for June contains an interesting paper by Mr. J. H. Gurney on birds and bird-migration in Norfolk and the east coast generally in 1903. As regards migration, it is pointed out that the prevalence of east winds is an important factor in producing an influx of visitors to this country, and also that while birds may leave Norway with a favourable wind *en route* for England, they are often driven from their course by encountering contrary breezes as they cross the North Sea. A notable incursion of waxwings during the year affords occasion for the remark that these birds do not visit England on account of excessive cold, but come under the category of late occasional migrants. Other rarities include a young sea-eagle, a flock of Nyroca ducks, half a dozen spoonbills, an avocet, and a blue water-hen. Spoonbills have made their appearance on the east coast continuously since 1897, and hopes are now entertained that they may once more breed in this country. To the same journal Mr. G. Renshaw contributes notes on the Amsterdam Zoological Gardens, in the course of which he repeats his mis-statement that the mounted quagga in the museum came from Knowsley.

IN the report for 1903, the trustees of the South African Museum take occasion to direct attention to the apathy displayed by the wealthy residents of South Africa to the institution under their charge, thereby presenting a regrettable contrast to their fellow millionaires in the United States. During the last twenty years all that the museum has received in the way of bequest and donation is the paltry sum of 295*l*., of which 100*l*. was given by an Indian gentleman. So far as its limited means permit, the museum appears to be making steady progress.—During the past year, according to the report, the attention of the staff of the Horniman Museum was largely directed to the development of the aquaria and vivaria which form such an attractive feature of that institution. A large number of British marine, land, and fresh-water animals have been from time to time on show during the year in the tanks and cases. Dr. Haddon's series of lectures appears to have been fairly well attended.—In the report of the Marlborough College Natural History Society, the secretary has to deplore the disastrous effect of the wet summer of 1903 on collecting and field-work generally, which has made itself felt in a decline of membership. The one compensation was the abundance of land molluscs, which was taken advantage of to compile a list of the local fauna. In other respects the society continues to flourish.

IN NATURE of February 11 (p. 349) we gave some particulars of the great rock-slide which occurred last year at Frank, in Alberta Territory, Canada. A full and interest-

ing report on the subject, by Messrs. R. G. McConnell and R. W. Brock, has since been issued by the Geological Survey of Canada (part viii., Ann. Rep. for 1903). The conclusions arrived at fully confirm the explanations previously given by Mr. Brewer, but the authors add that recent earthquake tremors no doubt hastened the time of the final disruption. They regard the present state of Turtle Mountain as dangerous, and recommend the removal of the town of Frank to a site higher up the valley of the Old Man River. The report is illustrated by map, sections, and numerous pictorial views.

The Geological Survey of India has revived the publication of its *Records*, a serial which was established in 1868, and amalgamated with the *Memoirs* in 1897. In justification of this step, the director, Mr. T. H. Holland, points out that during the course of the survey work many observations are made from time to time that it would be advisable to publish as promptly as possible, on account of their bearing on current scientific problems or of their economic value. The present number (vol. xxxi., part i.) contains accounts of coal-deposits, copper ore, sapphirine-bearing rock, together with miscellaneous notes on tin-ore, gem sands, &c., and selections from assays made in the laboratory relating to coal and manganese-ores. Mr. Holland expresses the hope that contributions will be made by private workers, to whom the *Records* will be open for original observations on geological subjects.

In the April *Bulletin* of the Johns Hopkins Hospital (xv., No. 157), Dr. George Dock discusses vaccine lymph and vaccination especially as regards American practice. Dr. Watts Lee publishes studies of the sinus frontalis of man and of certain mammals, carried out both by dissections and by means of lead casts, and Dr. Hastings describes a new blood stain possessing advantages over the Romanowsky and Leishmann stains, which should prove very useful, as it is permanent in the preparations, and the solution keeps well.

In Nature of March 17 (vol. lxix. p. 467) a review was given of the anti-malarial operations at Mian-Mir. A second report on the subject has now been published, and gives additional details (*Sc. Mem. of the Gov. of India*, No. 9, by Lieut. S. R. Christophers, I.M.S.). The conclusions are in accordance with those expressed by Captain James, I.M.S., in the first report. It is found that the destruction of the anopheles mosquito within an area by attacking their breeding places is extremely difficult, the mere obliteration of local breeding places being useless. Thus at Mian-Mir, although large numbers of pools were filled up and drained, and almost complete absence of breeding was ensured to a distance of half a mile, adult anopheles still appeared in large and increasing numbers, apparently due to immigration from without. Although a distinct effect was produced on the incidence of malaria among the troops and on the endemic index of the native bazaars, it was only evident at the beginning of the fever season, and could not be maintained. The value of quinine administration was found to depend on the efficiency of the supervision exercised; when quinine was regularly taken the admission rate for fever was much reduced. The conclusion is formed that although some effect on malaria was produced by anti-mosquito measures, these are not those best adapted at Mian-Mir to the eventual reduction of malaria.

The third issue of *The Central*—the journal of the Central Technical College Old Students' Association—is an excellent number. Prof. Armstrong, F.R.S., contributes the first of a series of short articles on the mechanism of combustion. Among other articles we notice two which are illustrated—one on popular motor cars, by Mr. M. O'Gorman, and the other by Mr. R. W. Sindall, on the manufacture of wood-pulp.

A second edition, revised and enlarged, of the "Student's Handbook of British Mosses," by Mr. H. N. Dixon, the first edition of which was reviewed at length in our issue of September 10, 1896 (vol. liv. p. 434), with illustrations and keys to the genera and species by Mr. H. G. Jameson, has been published by Mr. V. T. Sumfield, Station Street, Eastbourne. Since the publication of the first edition of the book, some thirty species or subspecies of British mosses have been detected, together with a corresponding number of varieties. These additions have been interpolated in the second edition, and notes also have been provided where recent knowledge necessitated their inclusion. Some slight alterations, too, have been made in the general arrangement of the book.

OUR ASTRONOMICAL COLUMN.

The Number of the Stars.—In No. 114 of *Popular Astronomy*, Mr. Gavin J. Burns makes some calculations and deductions as to the number of stars in the entire sky from the various star catalogues and photometric durchmusterungs which have been published. On the assumption that, on the whole, the stars are evenly distributed, he deduces from the plates taken for the Greenwich zone of the Astrographic Chart that there are 38 stars brighter than the second magnitude, 13,421 brighter than the seventh, and 8,325,000 brighter than the fifteenth. The ratio of the total number of stars brighter than any one magnitude to the number brighter than the next magnitude fainter is fairly constant at about 3·4 until the tenth magnitude is reached, but beyond that there is a sudden drop to 1·9, which ratio continues down to magnitude 15. From this discussion there is strong presumptive evidence that the stars thin out as their distance from our system increases.

Radial Velocities of the Pleiades.—From an investigation of a series of plates taken with the Bruce spectrograph, using only *one* prism, Mr. W. S. Adams, of the Yerkes Observatory, has determined the radial velocities of the Pleiades stars as follows:—

Name.	Bessel's number.	Mag.	Mean vel. in km.
Electra ..	17 Tauri ...	3·8 ...	+15
Taygeta ...	19 ,, ...	4·4 ...	+ 3
Merope ...	23 ,, ...	4·2 ...	+ 6
Alcyone ...	25 ,, ..	3·0 ...	+15
Atlas ...	27 ,, ...	3·8 ...	+13

Measurements of seven spectrograms of Maia (20 Tauri) indicate that this star has a variable velocity ranging from −7·4 km. (October 30, 1903) to +20·9 km. (December 25, 1903). The lines in the spectrum are well defined, so that although the range of variability is not very large, it is almost certainly real.

The spectra of Maia and Taygeta are at variance with what we should expect to find for stars associated with a nebula, and they engender a suspicion that these stars may not be physically connected with the surrounding nebula (*Astrophysical Journal*, No. 5, vol. xix.).

An Expedition for Solar Research.—With the aid of a grant of 10,000 dollars from the Carnegie Institution, the Yerkes Observatory has sent an expedition to Mount Wilson (altitude 5886 feet), near Pasadena, California, for the purpose of making special investigations of the sun.

The Snow horizontal telescope is to be the principal instrument erected. One of the concave mirrors of the coelostat reflector, having a focal length of 145 feet, will give a solar image 16 inches in diameter, and will be used for special spectroscopic studies of sun-spots and other solar phenomena. A spectroheliograph of 7 inches aperture and 30 feet focal length is also to be used in connection with this mirror. A stellar spectrograph provided

with a large concave grating is to be used to obtain, if possible, spectra of the brighter stars. The expedition is under the immediate direction of Prof. Hale.

THE ORBIT OF COMET 1889 IV.—The following elements for comet 1889 IV. have been calculated by Dr. Guido Horn, of Trieste, and are published in No. 5, vol. xxxiii., of the *Memorie della Societa degli Spettroscopisti Italiani*:—

$$\begin{aligned} T &= 1889 \text{ July } 19{\cdot}32298 \text{ (M.T. Berlin)} \\ \varpi &= 345^\circ\ 52'\ 42''{\cdot}83 \\ \Omega &= 286^\circ\ 9'\ 18''{\cdot}31 \\ i &= 65^\circ\ 59'\ 11''{\cdot}17 \\ \log q &= 0{\cdot}0169197 \\ \log e &= 9{\cdot}9990087 \\ \log a &= 2{\cdot}6590039 \\ \text{Period} &= 9738{\cdot}81 \text{ years.} \end{aligned}$$

A table showing the similarity of the orbit of this comet to those of six others which have appeared since 1684 is also given.

NEW LISTS OF VARIABLE STARS.—*Circular* No. 79 of the Harvard College Observatory contains a list of 19 new variable stars situated in the constellations Orion and Carina, and a list of 57 new variables in the region of the small Magellanic Cloud. A careful examination of 1167 star images, contained in a region 30′ square, on two plates of the Trifid nebula revealed no variables.

Circular No. 80 gives the positions and spectral characters of six new variables discovered by Mrs. Fleming on the Draper memorial photographs.

Circular No. 81 is devoted to some notes on eight variable stars of long periods prepared by Miss Cannon from her observations with the 6-inch telescope. The notes contain short comments upon the individual observations and on the agreement of the observed magnitudes on different dates with the various published elements for each star.

THE EDUCATION OF THE AMERICAN ENGINEER.

THE growing success of American and German manufacturers in the international competition for the world's markets has in recent years commanded alike the earnest attention of our industrial leaders and of our educational authorities. As numerous articles in these columns have testified, many serious attempts have been made during the past few years by expert observers from this country to try to discover the precise connection between foreign industrial success and the educational systems of the countries the competition of which has been brought home to us most decidedly; and the greatest attention has perhaps been given to the manner in which foreign engineers are prepared in schools and colleges for their life's work. It is little more than a year ago that Prof. W. E. Dalby laid before the Institution of Naval Architects and the Institution of Mechanical Engineers the results of his commission from Mr. Yarrow to report on the training of engineers in other countries, and as recently as May 5 the report of the Mosely Educational Commission, which dealt at some length with the same subject, was reviewed in NATURE. The most recent contribution to this important subject is a paper by Dr. Mullineux Walmsley read before the Institution of Electrical Engineers, and published in the *Journal* of that society for May. Dr. Walmsley was given leave of absence by the governing body of the Northampton Institute, of which he is principal, and was instructed to investigate the methods of higher engineering education in the United States and Canada, and more particularly the effect, so far as it could be ascertained, of the education on the engineering industries, the views of the great manufacturers and employers on the value of the products turned out by the schools, and the attitude generally taken up by them towards these schools. The paper embodying the chief conclusions at which Dr. Walmsley arrived and the more important of his observations runs to fifty pages, and a few typical examples only can be given in the space available.

The paper is divided into six sections, the first five of which are concerned with higher mechanical and electrical engineering education to the practical exclusion of other branches of engineering instruction. It was originally intended to include a chapter on the training of bench hands, fitters and erectors, but eventually Dr. Walmsley contented himself with the statement that in many respects "our arrangements here for the training of bench hands, &c., are better than the corresponding facilities provided in the United States and Canada."

The engineering schools and their resources are first described. The number and extent of the buildings devoted to higher engineering education exceeds, says the paper, anything that we can show in this country, but more often than otherwise Dr. Walmsley found that the supply of buildings was proving inadequate. There is evidence throughout these American schools of lavish expenditure on equipment on a scale to which we are, as yet, quite unaccustomed. The laboratories and workshops are packed full of apparatus and machinery for the use of students. The author states, "it is difficult within the limits of a paper not dealing exclusively with equipment to convey an adequate idea of its complexity or extent to those who have not visited the actual laboratories." The special needs of teachers and students engaged in research work receive particular attention by those who are responsible for the equipment of engineering workshops and laboratories, and the apparatus and fittings available include delicate instruments unlikely to be required by the ordinary student, but available for special investigations. It is interesting in this connection to quote an expression of opinion by Prof. Armstrong in the discussion on the paper:—"There may be a good deal of provision made for research, but there is not much evidence of research work being done. What the colleges are suffering from very largely is great over-provision of appliances and under-provision of teachers and well-prepared students."

Dr. Walmsley's remarks on the staffs of American engineering institutions agree with expressions of opinion to be found in the reports of Profs. Ayrton, Maclean, and Ripper in the volume dealing with the Mosely Educational Commission. It may be said to be generally admitted in America that professors of engineering must be practical men possessing a modern working acquaintance with engineering processes on a commercial scale rather than men possessed of high academic qualifications. It is recognised by Transatlantic authorities, too, that it is all to the advantage of the students if the professor is also actively engaged in engineering practice, either as an advising expert or in some other capacity.

Financial considerations are given great prominence in the paper, and much the same ground is covered as that traversed by an article in NATURE of May 14, 1903, on "The University and the Modern State," though Dr. Walmsley, in addition, makes an interesting attempt to separate the expenditure on engineering from that on higher education as a whole. Many of the conclusions arrived at by Sir Norman Lockyer in his Southport address to the British Association are quoted and substantiated by the author's own observations.

A comparison is instituted between the mental stock-in-trade with which American and English young men respectively start their engineering training, and though Dr. Walmsley does not claim that the school training provided in the United States is perfect, he has little doubt of the greater suitability of the American training for boys intending to become engineers: "both because of the later age of entrance, and also because their general education, as a rule, has been carried to a higher point, it follows that the candidate for entrance into the technical courses in America is better equipped than those in this country to take advantage of the training of the professional school." Here, again, we find Prof. Armstrong dissenting; he is inclined to doubt altogether whether the average product which enters the colleges in America is in the least degree superior to the average product coming up to our colleges.

Under the heading "The Work of the Schools," much valuable material as to the characteristics of the engineering courses in the colleges of the United States is brought together. The rule is that in the first two years of the course—which generally lasts four years—a fair amount of time is given to mathematics, English, modern languages and experimental science, and it is chiefly in the workshop and drawing office that the specialisation towards engineering is apparent during these two years. Specialisation

begins to show itself prominently early in the third year, and mechanical technology and electrotechnics are more or less taken up in the mechanical and electrical engineering courses. In the fourth year a crowd of engineering subjects is frequently introduced. An important part of the work of the fourth year is the preparation of a graduation thesis. The original intention, we find, of including such work in the time-table was undoubtedly to stimulate each student to produce, before he left the institution, a piece of original work which should be of some value in the development of science or of industry. In actual practice, however, the amount of original work produced is not very great, and it can be said fairly that only the best students do work which may be correctly dignified by the name of research. In most of the colleges post-graduate courses are organised, and in these the best work of the college is done.

But in no respect are American conditions more different from those at home than in the attitude of the employers of labour towards higher education. Just as the engineering experts on the Mosely Commission were unanimous in praising the interest shown by American manufacturers in the work of the colleges, so Dr. Walmsley testifies to the same fact. "Without exception the officials interviewed asserted that, far from having any difficulty in placing the graduates turned out year by year from the engineering courses, for the last few years the graduate class has had every one of its individual members engaged for remunerative work before the completion of the course at college." Later it is stated, "many of the large employers have made it a *sine quâ non* for entrance to any position which may lead eventually to a place on the scientific staff, that the candidate should have passed satisfactorily through the full four years' course at an approved technical institution." More than this, no premium is demanded, and living wages are given from the beginning, and these are raised as soon as the young beginner shows himself to be worth more.

Dr. Walmsley concludes his valuable paper with a summary of the respects in which this country is behind the United States so far as the education of its engineers is concerned. He enumerates the following deficiencies:— First, the comparative lack of support and encouragement of the work of the colleges by our leading manufacturers; secondly, that even were our employers ready to adopt the American plan of securing the services of students from the engineering schools, our present schools are neither equipped nor staffed to produce in sufficiently large numbers the trained men who would be wanted; and thirdly, that parents and guardians in this country have not yet been educated to understand how essential, in view of recent developments, a college training is to the success in the future of a candidate for the engineering profession.

As Mr. Buckmaster remarked during the course of the resumed discussion on Dr. Walmsley's paper, it "will be for a long time to come a sort of mine into which each of us will dig." This report together with the others to which reference has been made are more than sufficient to show educational authorities the direction in which our systems of instruction can be improved, and it is earnestly to be hoped that these and similar warnings will not have been uttered in vain.

A. T. S.

ARCHÆOLOGICAL INVESTIGATIONS IN RUSSIAN TURKESTAN.

DR. D. C. GILMAN, president of the Carnegie Institution of Washington, has received a letter in which Prof. R. Pumpelly describes some interesting results of his investigations upon ancient sites, at Anau, near Aschabad, in Russian Turkestan. The following extract from this communication will be welcomed by all who are interested in prehistoric and archæological researches:—

We have explored more than 136 feet of successive culture strata, containing at least four almost uninterrupted culture stages, extending apparently for thousands of years through the Neolithic and Bronze into the beginning of the Iron stage, and we have correlated the stages of culture with important events in the physiographic history and with the introduction of irrigation.

The streams that rise in the high mountains of northern Persia emerge on to the Turkoman plains forming fans, or subaërial deltas, covering many square miles, and each making an oasis. The water is all used in irrigating these fertile spots. Beyond them is the desert. Anau, where we have excavated, is on one of these fans.

Here at Anau, about seven miles east of Aschabad, there are two great tumuli, and the ruins of a city—Anau—surrounded by moat and wall, and occupied until within the last century. The two tumuli, nearly half a mile apart, are nearly equidistant from the city at a distance of less than a mile. We have explored both of these tumuli, and I have done some work in the city.

The northern and older tumulus rises 40 feet *above the plain*; the southern and younger tumulus rises 52 feet *above the plain*. Both of these start with their lowest culture strata on slight elevations in the same original plain-surface —more than 20 feet below the present surface of the surrounding plain. That is to say, the plain has grown up more than 20 feet since the settlements began. I will show, further on, the different phases of this growth.

In the older tumulus, we find a culture occupying the lower 45 feet, and distinguished by the technique and decoration of its wholly hand-made and interesting pottery. This is succeeded in the upper 15 feet by a more advanced culture in which some remnants of bronze implements and lead beads (all wholly altered to salts of the metals) show a beginning acquaintance with bronze, while the still hand-made pottery has changed and become more developed. Throughout this tumulus we have found nothing recognisable as a weapon of offence in either stone or metal, though flint knives abound.

The southern, younger tumulus, starts with a developed wheel-made pottery, unpainted, and of a technique wholly different from that of the older tumulus—though some hand-made pottery occurs not wholly unlike some of the younger products of the older tumulus.

From its base under the plain to its summit this tumulus has 74 feet of culture strata. There are evident here at least two successive cultures. Of these, that of the lower 62 feet is wholly in the bronze stage (but with survival of flint implements), while the upper 14 feet are marked by decided changes and by the introduction of iron, of which the wholly oxidised remnants of some implements were found.

We have thus at least four distinct cultures occupying 136 feet, with a break in the column between the end of the old and the beginning of the new tumulus. We do not know how great this gap may be.

Through all the cultures except the last—that of the iron stage—there ran a remarkable and characteristic burial custom. The children—at least certain children—and seemingly only children, were buried in the houses, under the floor, on a layer of fire-hardened earth.

In addition to the work on the two tumuli, I have sunk four shafts to the culture strata (30 to 40 feet thick) of the city of Anau, to try to determine its age relative to that of the youngest culture of the tumuli, and to get facts for use in deciding as to when irrigation was introduced. The results prove that Anau was wholly in the iron stage, while its wheel-made pottery is wholly different from any in the tumuli; but, in addition to this, fine-glazed faience was found plentifully in the upper three-quarters of all three shafts. These were not found at all in the tumuli, excepting in the case of two or three isolated and very doubtful pieces.

The history of the whole series of culture strata is sharply characterised by the following four periods in the history of the plain or subaërial delta:—

(1) The north tumulus when founded stood on a hill at least 7 feet, and probably more, above the plain surface, its culture spreading down the slopes. The plain was aggrading, and continued to grow until it had buried the base of the tumulus to a depth of 2 feet. By that time, or soon after, the north tumulus was abandoned, and the south tumulus culture founded, on an elevation about 2 feet above the plain. The plain continued to grow until it had buried the base of the south tumulus to a depth of 14 feet.

(2) Then followed a change of conditions. The plain was cut down at least 19 feet.

(3) This was followed by another change which caused the refilling of the cutting to the amount of 8 feet, 7 feet of this last growth having occurred after the deposition in

its sediments of the thoroughly characteristic pottery of the youngest (the iron culture) of the south tumulus.

(4) After this, and apparently contemporaneous with the founding of Anau, irrigation began through which the plain was raised 15 feet, bringing it to its present condition, in which the north tumulus stands embedded to a depth of 27 feet, the south tumulus to the depth of 22 feet, and Anau to 15 feet.

EFFECT OF SOUND ON WATER JETS.[1]

THE structure of water jets was first investigated by M. Savart, who in 1833 published a series of beautiful papers in the *Annales de Chimie et de Physique*. Since then it has received the attention of many experimenters, notably M. Plateau and Prof. Magnus, while of later years our knowledge of the subject has been much added to by the observations and mathematical researches of Lord Rayleigh. The older experimenters had to content themselves with observing the jet through a revolving disc with radial slots, but by means of an electric spark and rapid plates we can now secure photographs of the jet at any desired instant. The eye shows us that a jet of water consists of two parts, (1) a clear column, and (2) a troubled portion. The spark reveals to us that the troubled portion, though apparently continuous, is really a succession of drops, which move too rapidly for the eye to perceive them as such while under continuous illumination.

FIG. 1.—Some Instantaneous Photographs of Water Jets.

Towards the lower part of the clear column of water the jet presents alternate swellings and contractions, and at the very extremity a drop is cast off, leaving behind a connecting ligament, which separates and forms a smaller drop (Fig. 1). If the jet is falling freely, and subject only to accidental tremors and disturbances, the formation of drops is by no means regular, and the sizes and shapes of the drops vary much. If a vibrating tuning fork be held in contact with the stand, and if the pressure of water and the diameter of the orifice be suitable, the jet will appear like a vibrating string, a succession of nodes and loops being formed. The effect of the tuning fork is to render the separation of the drops regular, a drop being cast off with each vibration of the fork. If the jet be falling vertically, as the drop leaves the end of the clear column it is extended in a horizontal direction, but as it falls it oscillates about the spherical form, being alternately elongated and compressed under the action of the surface tension of the liquid (Fig. 2).

Prof. Magnus explained that the wavy appearance of the jet under the action of the tuning fork was due to all the drops which arrive at any given point of space being in the same phase; at the middle of a swelling they are most elongated horizontally, and midway between the broadest portions of two consecutive swellings they are most elongated vertically.

These remarks apply to a jet of water about 2 mm. in diameter. If the diameter of the jet be much less than 1 mm., swellings are not produced in it. The effect of a tuning fork is to render the drops practically equidistant and uniform in size (Fig. 3). If a fine jet be projected upwards (Fig. 4) it will be seen to consist of irregular drops, while the effect of a tuning fork upon it is often to cause it to break up into several distinct streams (Fig. 5).

[1] "The Structure of Water Jets, and the Effect of Sound thereon." By Philip E. Belas, Royal College of Science, Dublin. With photographs. Abstract of paper read before the Royal Dublin Society on March 15.

THE POISON OF THE BANDED KRAIT.[1]

THERE is an unbounded field in India for the study of the venoms of the many species of poisonous snakes met with in that country, and the Government of India has been well advised to devote to this subject certain of its scientific memoirs now being issued from time to time. Captain Lamb, I.M.S., the author of the one under review, has already done good work in this branch of research.

The venoms of various snakes, though all composed of the same class of chemical substances (coagulable proteids and proteoses) in varying proportion, differ markedly in their physiological actions, and it can be shown not only physiologically, but also by certain test-tube reactions, that the proteids and proteoses are different in the different venoms.

Thus the blood serum of an animal that has been injected with cobra venom causes a precipitate when mixed with an aqueous solution of cobra venom, but has no such action when mixed with a solution of the venom of the Australian tiger snake. As regards the venom of the banded krait (*Bungarus fasciatus*), with which this memoir deals, Captain Lamb's researches show that cases of poisoning may be divided into three classes:—(1) those in which after a large dose rapid death follows from the occurrence of extensive blood coagulation in the blood vessels; (2) those which are fatal after two or three days, and present acute

[1] Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India. No. 7, 1904. "Some Observations on the Poison of the Banded Krait (*Bungarus fasciatus*)." By Captain George Lamb, M.D., I.M.S. (Calcutta: Government Printing Office, 1904

nervous symptoms; and (3) those which run a chronic course and end fatally between the sixth and twelfth days after poisoning. In these, histological examination shows a well marked primary degeneration of the cells of the central nervous system, and to this the fatal issue is due.

The venom of the krait was found to be much less toxic than that of the cobra or of the daboia, and, unlike the former, has only a slightly destructive action on the red blood corpuscles. It, however, markedly increases blood coagulability, and may cause extensive intravascular clotting. Cobra and tiger snake anti-sera possess no neutralising action for the krait venom. The use of anti-sera, the only efficient antidotes for snake bites, must, therefore, unfortunately be limited, for it is necessary to have an anti-serum for the venom of every species. R. T. HEWLETT.

CURRENTS AROUND THE COASTS OF NEWFOUNDLAND.[1]

IN the course of the investigations described by Dr. Bell Dawson, a number of points were met with which are of general interest, as they probably characterise the currents on the margin of any large or oceanic area under similar conditions.

The currents in the above regions were examined last season from May to September, under the personal supervision of Dr. Dawson, the engineer in charge of the Tidal and Current Survey. Special attention was given to the question of indraught into the larger bays on the south coast, and to the behaviour of the Polar current which follows the eastern coast. For this work, the D. G. S. *Gulnare* was equipped with appliances for deep sea anchorage, and apparatus of a modern type, in some ways specially devised for the purpose. At anchorages carefully chosen, which were made in all depths up to 100 fathoms, the speed of the currents was measured, and the direction noted every half hour, day and night. The observations also included the under-current, the density and temperature of the water, the mileage and direction of the wind, and a continuous record of the tide on a self-registering gauge placed in a harbour in the region, for comparison with the set of the current.

The behaviour of these currents is very varied, and they were found to be so weak as to be readily influenced by the wind; but by a systematic reduction of the results, Dr. Dawson has prepared a report which describes the currents as concisely as possible, while avoiding technicalities. The report is divided into two parts; the first deals with the currents met with on the steamship route, which follows the south coast for 180 miles, and the question of indraught into the larger bays; and the second part describes the character of the Polar current on the east coast, and its possible change of direction when disturbed. The report is illustrated by nine diagrams and maps, which represent the results graphically. From this report, the following descriptions and explanations are culled, which are of general interest from a hydrographic point of view. References to the local geography are omitted as far as possible, as they might be inconvenient to follow without the map which accompanies the report.

Nature of the Currents.—The currents were almost invariably less than one knot. As a rule, they veered widely and were irregular in direction; and with so low a speed they were readily influenced by the wind. There were three elements to distinguish:—(1) Any general tendency to set in one direction more than in others. (2) Any tidal influence, which might show itself either as a marked change in the direction of the set, or as a period in which a variation in velocity would recur. (3) The influence of the wind in disturbing the usual behaviour of the current. From the observation, the effect of any storms which occur during the summer season seldom extends to a greater depth than 5 or 10 fathoms; and it was therefore found that the behaviour of the under-current at 15 to 30 fathoms afforded a most valuable indication of the normal character of the current. In these currents, the tidal element is almost invariably present in some form, more or less distinct; and this is almost always combined with a tendency to make on the whole in some one direction. It is not therefore possible to maintain an arbitrary distinction between "constant currents" and "tidal streams"; but the only natural distinction is to use the term *current* for all horizontal movements of the water, and *tide* for the vertical movement from high to low water.

The following features in these currents will be interesting for comparison with the behaviour of currents elsewhere, on the open coast of the ocean:—(1) When more than five miles from shore, there are no currents at any time throughout the season which exceed one knot in any direction. The only exception to this is the Polar current, in which a maximum speed of 1·15 knots was observed. (2) On the south coast, when within four or five miles of the shore, the current is chiefly governed by the tide, and sets in the two opposite directions alternately; but the farther out the point of observation, the greater the tendency for the direction of the current to veer completely around the compass. (3) The Polar current sets very constantly to the south-west, for a width of thirty or forty miles off the eastern coast. During times of disturbance, it may set south-eastward, or even be reversed, on the surface. When such disturbance occurs, it is usually for part of a day immediately before a gale comes on.

In the Polar current the influence of the tide was distinctly marked by a fluctuation in velocity, the current being 24 per cent. stronger during flood tide on the average. The under-current had the same general direction as the surface current. It set constantly to the south-westward, even at times when the current on the surface was most disturbed by the wind, judging from numerous observations at 40 fathoms, or about one-half the total depth of the water. The fluctuation in velocity with the tide was even more marked in the under-current than on the surface. During the flood tide, the strength from 15 to 40 fathoms was unusually constant, and at 40 fathoms it was always as strong and often stronger than on the surface. During the ebb tide it slacked below, as it did on the surface, and was usually weaker at the greater depths. When slackest, at about half-ebb, it fell below one-fourth of its greatest strength during flood tide, but even then the movement was distinctly felt to a depth of 60 and 75 fathoms.

Off the south shore, at an anchorage at an offing of seventeen miles, the behaviour of the current was very variable. During a period of nine days in June, when 158 hours of continuous observations were secured, a variety of weather conditions obtained, although the wind did not ever exceed twenty-one miles an hour. To understand the nature of the current, careful comparisons with the tides and winds are undoubtedly required; but the continuity of observations, taken every half hour day and night, affords a good basis for the comparison, and with an anemometer on board, the wind observations are much better obtained than by comparison with an observatory on shore.

The most evident change in the behaviour of the current is that sometimes the direction veers completely round the compass, and at other times it veers backwards and forwards between limiting directions. This change is evidently due to the variation in the amount of tidal influence with the springs and neaps. The veer completely around the compass occurs at neap tides, this being well marked at the moon's quarters on two different occasions. The veer is then continuously to the right, and the period in which a complete revolution occurs is just about sixteen hours. This period is quite definite, as deduced from six complete revolutions which were observed. It appears to result from a combination of the tidal period with a general movement of the water to the westward. This appears to be the only possible explanation, in accordance with the principles of rotary movement. This sixteen-hour period has been met with at other stations during the season, as well as in other regions in former years. At other times in the month, when the tidal influence is stronger, the current veers to the right and left through a range which varies from eight points to half a circumference. The complete period in which it veers and backs is from ten to fourteen hours. It is not impossible that this veer would be found to correspond with the tidal period if an average were taken which would be sufficiently long to eliminate other disturbing causes. On the other hand, at

[1] "The Currents on the South-eastern Coasts of Newfoundland. From Investigations of the Tidal and Current Survey in the Season of 1903." By Dr. W. Bell Dawson.

the neap tides, when the tidal element has the least influence, the sixteen-hour period throws the direction of the current entirely out of correspondence with the time of the tide.

Wind Influence.—It would be quite erroneous to suppose that the wind always causes a drift in its own direction. On the contrary, the set is primarily due to the nature of the current, and if it has any definite direction of its own, owing to the tide or other causes, it takes a strong wind a considerable time to overcome this, even with currents such as these, which do not exceed one knot.

A set of the current towards the point from which a wind is about to come is in accord with the universal testimony of the fishermen throughout these regions. Of all the signs of bad weather, it is the one which they appear to find the most trustworthy. In the summer, bad weather usually comes from the south-east and "blows itself out" from that direction; but later on, in the autumn, the wind chops round to the north-west before the storm is over. Along the south shore, it is only during ebb tide that there is a weak set to the south-east. Any strong set to the south-east or south is a sign of bad weather. The fishermen regard this as an unfailing indication, and at once run for shelter. The main feature is the fact of the current setting "into the weather," as they express it, and it is difficult to give a satisfactory explanation for this. The actual direction of the current is necessarily modified by local conditions and guided by the trend of the shore, but the greater scope and freedom the current has, the more directly it appears to set towards the coming wind. And further, it will set in either direction in accord with the expected wind. If this behaviour is due to difference of barometer, it is not easy to understand why the water should be the first to feel a change, before the wind itself begins to blow.

Density and Temperature of the Water.—Extended observations of density and temperature were taken during the season. This was done in the hope of tracing the movement of the water, as this method had proved so serviceable in the Gulf of St. Lawrence. The density of the water was taken at the surface only. The variation did not prove sufficient, however, to be relied upon as an indication of direction of movement. The temperature was taken to a depth of 30 fathoms, and more was expected from the temperature than from the density, as it was hoped it would serve to trace the course of the Polar current. The depth of 30 fathoms was found sufficient, as the water was there at the freezing point throughout the region examined, both south and east of Newfoundland, during the whole season from May to September. All the change which took place during the progress of the season or from other causes was between the surface and 30 fathoms. The change of the temperature of the water also afforded an interesting valuation for the amount of wind disturbance, and the depth to which it extended, under given conditions.

Two results were arrived at, which made the temperature observations of little value for the purpose of tracing the movement of the water by its temperature, and which it will therefore be sufficient to mention briefly:—(1) The temperature of the water at 30 fathoms is practically at the freezing point in all parts of this region, from the mouth of Placentia Bay to St. Johns. It varied only from $30\frac{1}{2}°$ to $34°$ F., and there was no change from one month to another, from May to September. (2) The water of the Polar current warms up quite as much on the surface as the surface water elsewhere in this region. The general increase of the surface temperature along the south shore, from St. Pierre to Trepassey, was from $36\frac{1}{2}°$ in May to $50°$ in September, and the surface temperature of the Polar current rose from an average of $34\frac{1}{2}°$ at the end of May to $50\frac{1}{4}°$ at the middle of August. Whether this increase of the surface temperature takes place during the progress of the current southward, or whether this warmer surface water flows over it from elsewhere, we have not sufficiently extended observations to determine. But for the guidance of the mariner, it is evident that the lower temperature cannot be depended on as an indication of the current-belt itself.

A very interesting result was met with, however, on account of the rapid fall in temperature from the surface downwards. The temperature proved to be a valuable indication of wind disturbance. During heavy winds, especially when off-shore, the surface water was driven out to the offing, and the cold under-water came up to the surface. A heavy fall in temperature would thus occur. For example, towards the end of August, the surface temperature over the area from Cape Spear to Cape Race was $50°$. There followed during three days 1312 miles of westerly winds, ranging from north-west to west-south-west, when the surface temperature within three miles of the shore fell to $36°$ and $34°$, and in a belt ten miles wide along the windward shore it was below $45°$. Careful observations and some special runs were made to ascertain the amount of lateral displacement of the current and the depth of disturbance due to a measured mileage of wind. This was done without loss of time, as the weather was then too heavy to carry on work at anchor. Later, when the weather moderated, the temperature again furnished a basis for a very fair estimate of the rate at which the current-belt moved back laterally to resume its usual course.

Ice as an Indication of Current.—To infer the behaviour of a current from the drift of ice with any certainty, the indications given by flat ice and by icebergs must be carefully distinguished. The flat or pan ice runs with the surface current, and is much influenced by the wind, whereas the icebergs indicate the average movement of the body of the water as a whole, and the wind has no appreciable effect upon them. This distinction is well known to sealers, and they habitually take advantage of it. When working against a gale of wind, they will moor their vessel to an iceberg, and lie in its lee while the small ice goes past with the drive of the wind, because, as they express it, the wind takes no hold on an iceberg at all. They thus save a long drift to leeward. It is thus from the icebergs rather than from the flat ice that we can find indications of value.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speeches delivered by Prof. Love in presenting recipients of the degree of D.Sc. *honoris causa* at the Encaenia, June 22, in the presence of the Chancellor of the university:—

THE HON. CHARLES ALGERNON PARSONS.

Duobus fere millibus abhinc annis Heron Alexandrinus turbinem quemdam per ludum excogitavit, qui vapore calido actus per tubos inflexos afflante converteretur. Carolus Algernon Parsons inter Hibernos nobilissimus, scientiae etiam laude insignis, ita Heronis vestigiis institit ut, quod ille ludendi causa finxerat, ipse in usum nostrum converteret, quo facilius homines naturae imperarent. Optime sane meritus est de omnibus qui urbes habitant, quibus vias et domos luce electrica hoc invento usus illustravit, neque minus profuit Nerea temptantibus, cum his turbinibus impulsae per altum naves celeritate inaudita ferantur recta semper carina adeo ut navigantium incommoda magna ex parte adleventur.

SIGNOR GUGLIELMO MARCONI.

Hic est ille magus, Gulielmus Marconi, qui modum invenit signorum ab ora in oram, a nave ad navem trans maria immensa transmittendorum. Docuerat quidem Maxwell, civis noster, vim electricam per aethera omnia permeantem quasi fluctibus quibusdam perferri. Accessit etiam Hertz, Germaniae ornamentum, qui ostendit quo modo hi fluctus ita regerentur ut tanquam procella quaedam electrica procul exorta aliis in locis satis longinquis agnosceretur. Marconi tandem, qua erat ingenii audacia, id excogitavit ut his subsidiis usus locos disiunctissimos quasi colloquendi quadam facultate coniungeret. Sollertia igitur maxima, patientia vero admirabili praeditus, singula impedimenta quae spei exsequendae obstabant felicissime pervicit, iamque potest nullo vinculo, nullo filo intercedente, quod vel oculi vel tactio deprehendere possint, super dimidiam orbis terrarum partem signa transmittere.

Sir William Selby Church.

Salutat Academia nostra unum ex alumnis suis, olim inter nos artis medicae doctorem, nunc Collegii Universitatis socium honoris causa creatum, Willelmum Selby Church. Academiae etiam personam gessit in communi illo medicorum Britannico consilio, penes quod regimen est examinationum in arte medica habendarum. Multos annos insignis est inter medicos qui mercede vel parva vel nulla accepta egentes in maximis valetudinariis Londinensibus curant: permulti etiam qui hodie in omni parte regni medicinam exercent hoc magistro et auctore studiorum usi sunt. Plurimum auctoritate valet in Regali medicorum Collegio, cui nuperrime Praeses iterum factus est: praemium denique singularium erga artem medicam et cives suos meritorum accepit Baronettus a regina nostra Victoria et Eques de Balneo a rege nostro Edwardo creatus.

Sir Andrew Noble.

Asclepium iure sequitur Mavors, plurium nisi fallor interfector. Ubicunque homines diras illas machinas moliuntur, quae novos bello terrores addiderunt, in honore est Andreas Noble, vir honoribus et insignibus a multis regibus, inter quos noster numeratur, saepe donatus propter operam in omni apparatu bellico praecipuam. Qui cum in exercitu Britannico summa laude meruisset iam rude donatus multos per annos maximae illi prope Tynam officinae praefuit ubi immania Vulcani tela et naves urbis instar habentes in usum nostrum et aliarum civitatum Cyclopes novi fabricantur. Sed quamvis Martis cultor insignis Minervae etiam acceptus est: hoc enim praeter ceteros operam dante et hortante Laboratorium maximum scientiae Physices augendae causa nuper institutum est, novo sane exemplo, unde patet rectores nostros, quantum civium utilitatibus prosit rerum naturalium scientia, aliquando intellegere.

Sir William Crookes.

In multis generibus quaerendi fructus magnos adsecutus est Willelmus Crookes. Ut a Chemia incipiam, novis analyseos modis usus a Kirchhoff et Bunsen in Germania excogitatis, qui substantias a luce quam ardentes emitterent aliam ab alia dignoscerent, ipse novum quoddam elementum, Thallium dico, invenit, prima spolia eademque opima his armis nactus. Eiusdem autem Thallii atomos etiam expendere potuit, quo nihil subtilius, nihil admirabilius. Primus etiam illud divinavit corpora materialia ita posse existere ut neque solida neque liquida neque vapora sint. Hoc demonstravit cum e tubulo aera extraheret donec spatium illud intra tubulum inclusum materia fere omni vacaret. Neque ipse solum in hoc curriculo feliciter versatus est, sed alii ex iisdem carceribus emissi alias palmas reportaverunt. Illud vero non silendum esse arbitror eum, cum de hoc genere quaereret, instrumentum quoddam effinxisse ad vim radiorum solis emetiendam, quod iure omnes inter miracula habent.

Sir David Gill.

In extremo Africae meridionalis promontorio sub tutela navium Britannicarum surgit turris ad siderum motus observandos destinata. Illic plus viginti iam annos magno astronomorum omnium emolumento caeli signa perscrutatus est David Gill. Illic rem quater de integro aggressus id adsecutus est ut distantiam, quae inter solem et nostram terram intercedat, accuratius quam quivis e prioribus emetiretur, adeo ut hodie omnes astronomi eius rationes pro veris habeant. Idem eodem modo distantiam inter solem et quindecim ex stellis, quae fixae vocantur, definivit. Accuratissimam etiam descriptionem fecit earum caeli regionum, quas non nisi Australe latus orbis terrae incolentibus spectare concessum, et in tabulis maximis faciendis, quibus variae caeli partes cura exquisitissima depinguntur, cui operi praeclaro omnes ubique gentes hodie incumbunt, rem felicissime navavit.

Sir John Murray.

Alia ex Colonia transmarina ad nos venit Ioannes Murray, qui quamquam origine Scotus media in Canada et natus et institutus est. De aqua marina, de animalibus mare habitantibus nemo est illo doctior. Harum rerum investigandarum causa navigationes plurimas fecit. Triginta quidem abhinc annos, cum novi quidam Argonautae a rectoribus nostris publice missi sunt, qui ex omni mari materiam scientiae colligerent, ipse inter delectos heroas fuit. Fructus vero illius navigationis quinque et quadraginta magnis commentariorum voluminibus continentur, quibus omnes usi sunt, qui de natura salis, de calore maris, de marinorum animalium formis et agendi rationibus postea scripserunt. Maximas profecto gratias habent omnes qui rerum naturae student Ioannae Murray horum commentariorum editori.

Prof. Alfred Marshall.

Academia nostra particeps est laudis quam adsecutus est Aluredus Marshall. Cum enim in litterarum commercio ea ratione semper uberetur quam hic in rebus venalibus constantissime vindicavit ut amico portu advenas omnes reciperet, hunc virum magno cum fructu inter suos adscivit, quamquam Cantabrigiae olim mathematicae studuit et in eadem Academia nunc Oeconomias Professor est. Primus hic inventus est qui rationibus mathematicis fretus, quae antea tantum ad naturam rerum cognoscendam a physicis adhibitae sunt, de commercio hominum et societate quaereret. Cum in omni analyseos genere doctissimus esset, symbolis tamen parcissime est usus, et diviti cuidam ratiocinandi venae rerum minutissimam cognitionem addidit, unde factum est ut opus illud maximum de Oeconomias principiis non solum scientiae maturae et perfectae artis sed etiam sapientiae altissimae monumentum exstet.

Prof. J. J. Thomson.

Inter Naturae venatores qui experimentis faciendis praecipue incumbunt Iosephus Ioannes Thomson dux est et signifer. Qui rationibus felicissime conceptis id demonstravit, quod nonnulli prius suspicati sunt, atomos illas, e quibus constat materia rerum, e minutissimis quibusdam et fere innumerabilibus corpusculis conglutinatas esse, quae tamen ipse et enumerare et expendere potuit. Neque hoc tantum adsecutus est, sed in vi electrica et magnetica et in natura atomorum cognoscenda se semper exercuit. Nos qui audivimus luculentissimam eius orationem cum nuperrime in hac Academia contionatus est, qui vidimus pulcherrima illa experimenta, quibus rationes suas probavit, minime mirabimur, cum omnes ex omnibus gentibus huius scientiae avidos se Cantabrigiam conferre, tum ex eius fontibus tot discipulos uberrimo cum fructu suos hortulos irrigare.

Prof. Horace Lamb.

Et hic et apud Antipodas summam laudem adeptus est Horatius Lamb, qui et in Academia de Adelaide, cum in Australia versaretur, et Mancuniae in Academia Victoriana mathematices optimos studendi modos ostendit. Neque solum in rebus Academicis gubernandis maxime floret, sed de rationibus physicis secundum mathematicam artem tractandis libros optimos scripsit, quos omnes in manu habent, velut de fluidorum motu, de luce, de vi electrica, de sonitu, de scientia machinali: nuperrime etiam de terrarum motibus luculentissime disseruit. In his operibus ita tenuissima illa analysi, quae mathematicorum propria est, ad rationes physicas expendendas usus est, ut saepe res tenebris ante sepultas nova luce illustraret. Pauci sane hodie sunt qui de tot scientiae generibus egerunt: qui melius et probabilius de ullo scripserit, nemo est.

Prof. A. R. Forsyth.

Scientiam mathematicam qualis hodie est tanquam monumentum esse videtur multorum laboribus multis in terris sensim aedificatum: inter quos locum insignem tenet Andreas Russell Forsyth, non solum quod ipse huic praeclaro operi multos lapides imposuit, sed quod haec omnia quasi calce et caemento conglutinavit. Augustinus Cauchy, Bernardus Riemann, Carolus Weierstrass, hi Germani, ille Gallus, analyseos problemata tribus viis aggressi, quisque pro se summi momenti res reppererant: quae inventa ut in unam rationem congruentem conflaret, ut vinculis et nexibus coniungeret, ut his tribus quaerendi modis usus cognitionis humanae fines promoveret, inventus est Andreas Forsyth. De quo illud affirmare possumus si Fata eum insignem inter mathematicos non fecisset, insignem in re publica gubernanda fecisset Natura, adeo eius consilia in rebus Academicis Cantabrigienses sui petunt, tanti eius iudicium ab omnibus aestimatur.

PROF. J. DEWAR.

Liquidone de aere loquitur quis? Occurrit menti Iacobus Dewar. Quid enim? Partem aliquam aeris circumambientis corripere, secernere in vasculo, cogere ut modo fluat sicut aqua, modo congeletur sicut glacies, nonne haec ultra ingenii humani fines videntur? Quae tamen posse fieri iamdudum notum est: immo, aliquando facta sunt, sed in tenui erat et labor et successus. Ulterius vero progressus est Iacobus Dewar, qui cum neque impensae neque labori neque cogitationibus suis parceret, instrumenta exquisitissima perfecit, quibus vis aliqua maior vel aeris vel tenuissimarum illarum substantiarum ipsum aera subtilitate superantium modo liquida modo solida fiat. Ita nova quaedam et potentissima Naturam investigantibus subsidia, quibus ipse maximo cum fructu usus est, aliis tradidit, cum materia qualis sit omni fere caloris particula ablata homines iam cognoscere possint.

PROF. J. LARMOR.

Newtonus ille, "qui genus humanum ingenio superavit," solem terram lunam planetas nutu quodam et pondere contineri docuit, et motus suos conficere hac vi compulsos. Cui successit his diebus Iosephus Larmor, cathedrae Newtonianae novissimum decus, qui vir ingenio Hibernus, mathematices scientia vere Cantabrigiensis, id fecit ut in omni omnis corporis atomo mundi imaginem expressam videremus, cum doceret particulas minutissimas, e quibus corporum atomi constent, vi electrica contineri et hoc momento coactas quasi per orbitas agitari. Quae doctrina non modo in ordinem convenientem redegit quidquid antea de luminis natura de vi electrica et magnetica compertum est, sed nodos difficillimos, quibus implicantur ii qui experimentis faciendis se totos dant, omnes exsolvit.

AT presentation day of the University of Manchester on July 2, the honorary degree of D.Sc. was conferred on Prof. B. Brauner, of the Czech University of Prague, Dr. Ludwig Mond, F.R.S., and Dr. W. H. Perkin, sen., F.R.S.

THE Schunck Laboratory, which was bequeathed to Owens College by the late Dr. Schunck, and has been removed from his residence at Kersal and rebuilt in the college precincts as nearly as possible in its original form, was formally opened by Dr. W. H. Perkin, F.R.S., last week.

WE learn from *Science* that at the recent commencement exercises of Columbia University a gift of 50,000*l.* from Mr. Lewisohn was announced, to be used for a building for the School of Mines. It is also reported that the sum of 65,000*l.* has been collected for MacAlaster College in Minnesota. The largest gifts were 20,000*l.* from Mr. C. D. Dayton and 10,000*l.* from Mr. J. J. Hill.

THE first volume, January to June, 1904, of *School*, the new educational periodical published by Mr. John Murray, has now been issued. It contains a good supply of articles on educational subjects of theoretical interest which will appeal to the student of pedagogics. Matters of educational administration, and notes on the way in which the recent Education Acts are being utilised by local authorities, are given a prominent place. The teaching of science, and topics of especial interest to those engaged in this part of school work, receive but little attention.

IN connection with the opening of the new laboratories and workshops by Sir William H. White, K.C.B., at the Merchant Venturers' Technical College, Bristol—which was announced in our issue of June 9—the governing body has issued a lavishly illustrated "Souvenir," which provides an excellent account of the work and equipment of the enlarged institution. In tracing the growth of the college during the last fourteen years, the pamphlet shows that during this period the number of adult students attending the day classes has increased five-fold, the number in attendance in 1890 being 48, and this year 242. It is only necessary to read the descriptions of the workshops provided for the technical instruction of printers, bookbinders, painters, plumbers, and engineers of various kinds to appreciate how much is being done in Bristol to train fully qualified workmen for the city's industries, and the large number of students who attend the courses of work provided shows that the men themselves appreciate what is offered. The provision of classes in the branches of science associated with these technical subjects is also satisfactory.

THE recently published "Besuchs-Statistik" for the semester ending in March last shows that there were 37,854 matriculated students studying in German universities, including 3093 foreigners (this is the highest total ever reached by the non-German element); the number of non-matriculated students was 9187, thus making a sum total of 47,041. Of the different universities, Berlin easily stands first with 7503 matriculated and 6353 non-matriculated students. The next in numerical order are Munich with 4609, Leipzig with 3772, and Bonn with 2294 students of all classes. Breslau and Halle have each more than 1500, and the following nine universities more than 1000 students:—Tübingen, Göttingen, Heidelberg, Strassburg, Freiburg, Würzburg, Münster, Marburg, and Giessen. Of the foreign students 2620 are Europeans, consequently leaving 473 who hail from the other continents. Among these 2620 European students, Russia, with 986, sends considerably the largest contingent; then follow Austria and Switzerland. It is a remarkable fact shown by the statistics that by far the largest proportion of non-matriculated to matriculated students, viz. 42 per cent., is to be found in Berlin. The weaker sex, represented at all the universities except Münster, Greifswald, and Rostock, forms a seventh part of the total of non-matriculated students. Berlin claims the largest portion of Germany's lady students, for 42 out of every 100 prefer to study in the Imperial capital, the universities next in favour being Breslau, Bonn, and Strassburg, but here their numbers never exceed 100. The total number of students at the French universities for the semester ending in March was 30,405. Here again the university in the capital easily heads the list with 12,948 students. Then come Bordeaux, 2320; Toulouse, 2191; Montpellier, 1707; Nancy, 1327; Rennes, 1190; Lille, 1164; Aix-Marseille, 1080; Dijon, 880; Poitiers, 863; Caen, 752; Grenoble, 705; Besançon, 333; and Clermont, 299. 10,972 belonged to the law faculty, 6686 to the medical, 4765 to the science, 4384 to the arts, 3014 to the "pharmaceutical" faculty. The numbers of foreigners, amounting to nearly 2000, included 450 Russians, 200 Persians, 175 Roumanians, 165 Germans, 109 Bulgarians, 113 Turks, 83 Egyptians, 57 Americans, and 35 English students. The sum total of women students amounted to 1125, of whom 677 were of French nationality and 448 foreigners—almost entirely of Russian birth.

THE Senate of the University of London, at a meeting on June 28, considered a report from the committee appointed to deal with the offer of the Goldsmiths' Company to transfer to the university the Goldsmiths' Institute at New Cross. The Senate decided to accept the munificent offer of the company, and an *ad interim* committee was appointed to carry out the reorganisation of the institute. To meet the needs of the county councils of London, Middlesex, Kent, and Surrey, and the borough council of Croydon, it is proposed that a day training college for about 400 students shall be opened in the Goldsmiths' Institute in the autumn of 1905. In connection with this college it is considered important that day classes should be held preparatory for the intermediate examinations, or up to the standard of the intermediate examinations, in arts and science. This scheme will absorb the funds at the disposal of the university, which will thus be unable to carry on other classes unless it receives further financial support. Should such support be forthcoming, it is prepared to carry on at New Cross the higher part of the work of a polytechnic, and to continue the existing school of art. It will not be possible for the university to continue the social and recreative side of the institute. The scheme has received the full approval of the Goldsmiths' Company. The Education Committee of the London County Council has also had the affairs of the Goldsmiths' Institute under consideration, and on Tuesday the council accepted its recommendations to inform the Goldsmiths' Company that the council would view with regret the closing of the Goldsmiths' Institute and the termination of its educational work as a polytechnic, and inviting the company to consider whether some arrangement cannot be come to by which the work of the institute could be con-

tinued in its present polytechnic form. Another recommendation accepted states, among other points, that, in the event of its proving impossible to secure the continuance of the Goldsmiths' Institute as a polytechnic, the council would regard it as of great importance to secure its retention as a centre of evening instruction in as many subjects as possible, especially in the higher grades, and to arrange for the continuance of an efficient department of mechanical and electrical engineering for evening students.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 9.—"The Fossil Flora of the Culm Measures of North-west Devon, and the Palæobotanical Evidence with regard to the Age of the Beds." By E. A. Newell **Arber**. Communicated by Prof. McKenny Hughes, F.R.S.

The Carboniferous rocks of Devonshire, generally known as the Culm Measures, are divided into an Upper and a Lower division. The Upper Culm Measures, which are of Upper Carboniferous age, form by far the thickest portion of this Carboniferous series. Plant remains, although abundant in these beds, are rarely sufficiently well preserved to admit of identification. A number of species have, however, been obtained, some of which are new to Britain, from the one horizon in the Upper Culm Measures in which coal, known locally as culm, is found. This flora is identical with that of the Middle Coal Measures elsewhere in England, and consequently the horizon on which the coal or culm occurs in the Bideford district is the equivalent of the Middle Coal Measures, a higher horizon than has been previously assigned to these beds.

There is also evidence that the Culm Measures at Instow, which occupy a lower horizon than the Culm Measures of the Bideford district, are probably the equivalents of the Lower Coal Measures. Thus both the Lower and Middle Coal Measures are represented in Devonshire, and, as the higher beds of the Culm Measures are as yet unexplored, possibly even higher horizons may eventually be found to be represented.

It is pointed out that the Culm Measures of Devon, which have been regarded by several geologists as essentially a Lower Carboniferous formation, are in reality chiefly, but not entirely, of Upper Carboniferous age. Consequently, the term "culm" or "kulm" generally applied to certain deposits in Germany, Austria, and elsewhere on the Continent, which are entirely of Lower Carboniferous age, is peculiarly unfortunate, for these beds are not of the same age as the great bulk of the Devonshire Culm Measures.

June 16.—"The Decomposition of Ammonia by Heat." By Dr. E. P. **Perman** and G. A. S. **Atkinson**.

Ammonia gas was heated in a porcelain globe placed in a muffle furnace, and the total pressure of the ammonia and decomposition products was read by means of a mercury manometer at equal time intervals, the volume being kept constant. The temperature was measured by a Callendar-Griffiths pyrometer, and was maintained constant within 1° or 2°; in the various experiments it varied from 677° to 1111°.

At the end of each experiment the temperature was raised to about 1100°, and maintained at that point until the decomposition of the ammonia was practically complete; the pressure was then read again, and from it was calculated the initial pressure of the ammonia in the globe.

Let p_1 be the pressure of the ammonia at any instant during the decomposition, p_1' that of the nitrogen, p_2' that of the hydrogen, P the total pressure at the same instant, p_0 the initial pressure of the ammonia, then $p_1+p_1'+p_2'=P$, $p_2'=3p_1'$, and $p_1'+p_2'=2(p_0-p_1)$; from these equations it follows by substitution that $p_1=2p_0-P$, *i.e.* the pressure of the ammonia at any instant is double the initial pressure minus the total pressure at the instant of observation. The experimental data furnish values of P and $2p_0$, and values of $2p_0-P$ have been calculated and tabulated; from the latter were calculated $\Delta P/\Delta t$; but $\Delta P/\Delta t=dP/dt$ approximately, and $dP/dt=dp_1/dt$, so that the rate of change of pressure of the ammonia at various pressures becomes known. Two series of curves have been drawn showing the variation of the rate with the pressure. The most noteworthy features of the curves are:—(1) at the highest temperatures they become straight lines; (2) they all run towards the origin; (3) they become much steeper when certain metals (mercury, iron, or platinum) are present in the globe. The chief deductions are:—(1) the decomposition is monomolecular; (2) and (practically if not completely) irreversible; (3) the rate of decomposition is much increased by the presence of certain metals.

Some experiments were made also on the effect of sudden change of pressure on the rate of decomposition; the results confirmed the conclusion that the reaction is monomolecular. The irreversibility of the reaction was confirmed by passing nitrogen and hydrogen through a red-hot glass tube containing porcelain, when no ammonia was found to be produced.

Royal Astronomical Society, June 10.—Prof. H. H. Turner, president, in the chair.—Mr. A. R. **Hinks** read a paper on the reduction of 295 photographs of Eros made at nine observatories during the period 1902 November 7–15, with a determination of the solar parallax; 110 of the plates were taken at Cambridge, the remainder at Algiers, Lick Observatory, Northfield Observatory, Oxford, Paris, and other observatories. The author described the method employed in the reductions, &c., and gave as the resulting value for the solar parallax $8''.7966 \pm 0''.0047$, a result nearly in accordance with that obtained by Sir D. Gill from heliometer observations of minor planets.—Mr. M. E. J. **Gheury** read a paper on the gyroscopic collimator of Admiral Fleuriais. In this instrument the principle of the gyroscope was employed to furnish an artificial horizon for sextant observations at sea. The instrument was shown to the meeting, and its construction and method of employment were described.—Mr. Bryan **Cookson** gave an account of his paper on the mass of Jupiter, and corrections to the elements of the orbits of the satellites, from heliometer observations made at the Cape Observatory during the years 1901 and 1902. The methods of observation and reduction were explained, and a brief account given of the results.—Mr. E. W. **Maunder** read a paper on the distribution of sun-spots in heliographic latitude during the years 1874 to 1902. The author considered Spoerer's law for the distribution of sun-spots to be true within the limits of its enunciation—that there is only one spot zone in either hemisphere except during the brief period just after minimum.—The Rev. A. L. **Cortie** read a paper on the variation of latitude of the greater sun-spot disturbances, 1881–1903. Dr. Lockyer briefly replied, contesting some of Mr. Maunder's conclusions.

Chemical Society, June 15.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The following papers were read:—The mechanical analysis of soils and the composition of the fractions resulting therefrom: A. D. **Hall**. The object of the investigation was to ascertain the effect of introducing into the mechanical analysis of soils a preliminary treatment of the soil in dilute acid followed by ammonia, as first suggested by Schlœsing. Eighteen soils of known history were selected from the Rothamsted experimental plots, to give comparisons of the same soil in an unmanured condition and when rich in humus through the accumulation of organic matter. With these soils the method involving a preliminary treatment with acid showed the essential identity of soils from the same experimental field whatever the manuring had been, whereas the analyses made on the raw soil gave very different results, depending on the treatment the various plots had received.—The effect of the long-continued use of sodium nitrate on the constitution of the soil: A. D. **Hall**. On reviewing the results of the mechanical analysis of the Rothamsted soils, it was observed that those which had been manured with sodium nitrate every year gave abnormal results for the last fraction. The removal of the finest particles from the surface soil is attributed to deflocculation induced by the use of sodium nitrate, and followed by the washing of the finest particles into the subsoil.—The decomposition of oxalates by heat: A. **Scott**. It is shown that the decomposition of oxalates by heat is less simple than is generally supposed, and that, except in the case of magnesium oxalate, the oxalates of the common metals generally yield a small

quantity of carbon.—Some alkyl derivatives of sulphur, selenium and tellurium: A. **Scott**. A description of the derivatives obtained by the action of various alkyl iodides on these elements.—The ultra-violet absorption spectra of certain *enol-keto*-tautomerides, part i., acetylacetone and ethyl acetoacetate: E. C. C. **Baly** and C. H. **Desch**. From comparative observations of the absorption spectra of these compounds under various conditions, the conclusion is drawn that with acetylacetone, ethyl acetoacetate, and their metallic derivatives, a state of dynamic isomerism exists in the solutions, and that this isomerism is evidenced by a characteristic band in the spectra.—The action of acetyl chloride on the sodium salt of diacetylacetone and the constitution of pyrone compounds: J. N. **Collie**. A description of three isomerides obtained in this reaction, from the study of which the author has been led to assign a new constitution to pyrone and its derivatives.—Our present knowledge of the chemistry of indigo: W. P. **Bloxam**. Some observations on the purity of commercial indigotin and on the composition of indirubin were made.—$\Delta^{1:3}$-Dihydrobenzene: A. W. **Crossley**. A description of the formation and properties of this substance is given.—The absorption spectrum of *p*-nitrosodimethylaniline: W. N. **Hartley**. The absorption caused by *p*-nitrosodimethylaniline at the less refrangible end extends into the infra-red, and at the more refrangible far into the ultra-violet. The transmitted rays are thus restricted to a band of yellow and green light bordered on either side by a band of intense absorption. The alkyl-substituted phenols and anilines absorb varying quantities of the ultra-violet, the absorption not extending into the visible spectrum; but it is also shown that the introduction of the NO, as distinguished from the NOH group, extends the absorption far into the coloured rays.—The influence of solvents on the rotation of optically active compounds, part vi., the relationship between solution-volume and rotation of the dialkyl and potassum alkyl tartrates in aqueous solution: T. S. **Patterson**.—The constitution of hydrastinine: J. J. **Dobbie** and C. K. **Tinkler**. Solutions of hydrastinine in ether or chloroform are colourless, and their absorption spectra are practically identical with the spectra of hydrohydrastinine. From this it is argued that the carbinol formula should be preferred to the open-chain or aldehydic formula of Roser. On the other hand, the aqueous or alcoholic solutions of hydrastinine give spectra which agree with those of the hydrastinine salts, whence it would appear that, under the influence of these solvents, hydrastinine changes from the carbinol to the ammonium base.—The influence of moist alcohol and ethyl chloride on the boiling point of chloroform: J. **Wade** and H. **Finnemore**. Chloroform made from alcohol contains, in addition to alcohol, a small quantity of ethyl chloride, both of which depress the boiling point.—Limonene nitrosocyanides: W. A. **Tilden** and F. P. **Leach**. The nitrosocyanide described by Tilden and Burrows as a liquid is found to be a crystalline optically active solid having m.p. 90–91°, and $[\alpha]_D + 165°$.—Photochemically active chlorine, ii., a preliminary notice: C. H. **Burgess** and D. L. **Chapman**.—Additive compounds of anhydrous magnesium bromide with organic oxygen and nitrogen compounds: J. J. **Sudborough**, H. **Hibbert**, and S. H. **Beard**.—Differentiation of primary, secondary, and tertiary amines. A preliminary note: J. J. **Sudborough** and H. **Hibbert**.—Influence of radium radiations on labile stereoisomerides: J. J. **Sudborough**. The results indicate that *allo*-cinnamic acid and its α and β bromo-derivatives are transformed more readily under the influence of sunlight than by prolonged exposure to radium radiations.—Notes on analytical chemistry: G. T. **Morgan**. The separation of arsenic by distillation in hydrogen chloride. The estimation of carbon by oxidation with chromic acid.—Nitrogen chlorides containing two halogen atoms attached to the nitrogen: F. D. **Chattaway**.—Sulphonphenylchloroamides and sulphontolylchloroamides: F. D. **Chattaway**.—Stereoisomeric glucoses and the hydrolysis of glucosidic acetates: E. F. **Armstrong** and P. S. **Arup**. It was shown that the acetyl groups are removed with unequal readiness from the penta-acetates of glucose and galactose and from sucrose octaacetate, and with equal readiness from the tetra-acetates of the methylglucosides and galactosides.—The colouring matter of the flowers of *Butea frondosa*: A. G. **Perkin**. This dye-stuff is shown to contain two substances, *butin* and *butein*, which are closely related in constitution, the former being a chalkone compound and the latter the corresponding flavonone isomeride.—Cyanomaclurin: A. G. **Perkin**. This product, which exists in jackwood, closely resembles the catechins in constitution, and is probably derived from them by the replacement of a catechol nucleus by resorcinol.—The determination of acetyl groups: A. G. **Perkin**. A description of a hydrolytic method of estimating acetyl groups in organic compounds.—Note on the catechins: A. G. **Perkin**. A description of the acetyl derivative of the catechin (*acacatechin*) derived from *Acacia catechu* is given.—A constituent of Java indigo: A. G. **Perkin**. It is shown that the yellow colouring matter present in Java indigo is identical with kampherol.

Royal Microscopical Society, June 15.—Dr. D. H. Scott, F.R.S., president, in the chair.—A direct proof of Abbe's theorems on the microscopic resolution of gratings: Prof. J. D. **Everett**. The image of the grating formed by the objective is the resultant effect of the disturbances in the image plane due to the diffraction spectra formed in the focal plane. The optical path measured from a plane wave-front, before incidence on the grating, to the spectrum of order 0, is unaffected by displacement of the grating. The path to a spectrum of order 1 is altered by $\lambda x/s$, and to a spectrum of order n by $n\lambda x/s$, by a shift x of the grating, s denoting the distance between rulings. At a fixed point P in the image plane, the interference of the spectrum of order 0 with a spectrum of order n goes through a complete cycle, while x increases by s/n. That is, n lines in the image move across P during a displacement s of the grating. Similar reasoning applies to the interference of any two of the spectra, and gives Abbe's results. A displacement x towards either side diminishes the paths to the spectra on this side, and increases the paths to the spectra on the other side. When only one spectrum operates, there is no interference and no alternation of brightness.—The recent Foraminifera of the Malay Archipelago: F. W. **Millett**.—Nature's protection of insect life: F. **Enock**.

Physical Society, June 24.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—Chemical dissociation and electrical conductivity: A. E. **Garrett** and Dr. R. S. **Willows**. It has been shown by Beattie (*Phil. Mag.*, 1899) that a mixture of salt and iodine, when placed on a zinc plate and heated, gives rise to electrical conductivity, although separately no such effect is produced. This is shown to be due to the formation of zinc iodide. Following on this the electrical conductivity produced by heating various salts is investigated under different conditions of temperature and electric field. A large excess of positive electricity is found in nearly every case.—The magnetisation of iron in bulk: Dr. W. M. **Thornton**. The paper is in three sections. The first describes a method of measuring large quantities of magnetism by the use of an exploring coil placed around the core and an exciting coil in series with a recording milli-voltmeter. The second section deals with the curves of rise of magnetising currents, when the core is solid and when laminated, as affected by the reaction of the core-currents, and also by the change of permeability during magnetisation. In the last section an example is given of the sudden dip in the curve of rise observed only with large cores.

PARIS.

Academy of Sciences, June 27.—M. Mascart in the chair.—Researches on cyanogen: solubility and polymerisation: M. **Berthelot**. There is no true coefficient of solubility of cyanogen in water or alcohol, a slow chemical reaction taking place from the first. With other solvents, such as acetic acid, turpentine, chloroform, and benzene, the ordinary laws of solution are obeyed.—Researches on cyanogen and on its reaction with potassium cyanide: M. **Berthelot**. An attempt to prepare polycyanides corresponding to the triiodides was not successful. Cyanogen is rapidly absorbed by a solution of potassium cyanide, but no compound corresponding to potassium triiodide was obtained, the gas being partly hydrolysed and partly polymerised.—On the distribution of time at a distance by means of wireless telegraphy: G. **Bigourdan**. The experiments described have been successful up to a distance of 2 kilo-

metres, and there seems no reason to suppose that the signals could not be easily sent over much longer distances.—On the distillation of a mixture of two metals: Henri **Moissan** and M. **O'Farrelley.** Alloys of copper, lead, zinc, cadmium, and tin were heated in carbon boats in the electric furnace. The alloys behaved exactly as in an ordinary fractional distillation, the composition varying with the time of distillation and the quantity of metal distilled. Thus with alloys of zinc and copper, cadmium and copper, lead and copper, a residue could be obtained after a certain time consisting of pure copper.—The influence on the rotatory power of certain molecules exerted by non-saturated radicals. The allyl ethers of borneol, menthol, methylcyclohexanol, and linalool: A. **Haller** and F. **March.** With one exception, the ethers possess a higher rotatory power than the active alcohols from which they are derived. With the same exception, the molecular refractive powers found are in accord with those calculated.—Muscular work and the expenditure of energy in dynamic contraction: A. **Chauveau.**—Improvements in the photographic method for recording the action of the *n*-rays on a small electric spark: R. **Blondlot.** The improvements on the method previously described include the use of an aluminium lens for concentrating the rays from the Nernst lamp on the spark gap, together with some details necessary for the working of the spark. Very slow development of the negative is required to bring out the effect clearly.—The action of magnetic and electric forces on ponderable emission; the effect of air in motion on this emanation: R. **Blondlot.**—M. Maquenne was elected a member of the section of rural economy in the place of the late M. Duclaux, and Prof. Waldmeyer a correspondant in the section of anatomy and zoology in the place of Prof. A. Agassiz, elected foreign associate.—On certain classes of isothermal surfaces: L. **Raffy.**—On a class of partial differential equations of the second order: J. **Clairin.**—Remarks on the propagation of percussions in gases: E. **Jouguet.**—On a new aërial helix: H. **Hervé** and H. **de la Vaulx.**—The dielectric cohesion of the saturated vapour of mercury and its mixtures: E. **Bouty.** The experiments were made in a fused silica flask, which satisfied the necessary condition of possessing no conductivity at the temperature of the experiment. The cohesion of mercury vapour is only 0·85 that of air, which, having regard to the high density of the vapour, is remarkably small. The effect of introducing various gases with the mercury vapour was also studied.—The transport of ultramicroscopic particles in the current: A. **Cotton** and H. **Mouton.**—On a new method of three-colour photography: R. W. **Wood.**—On the yellow and red varieties of thallium iodide and the determination of the normal point of their reciprocal transformation: D. **Gernez.** The transition point was determined as 168°, or 22° lower than the figure usually accepted.—On the nitrate and nitrite of thallium: U. **Thomas.** Thallous nitrate is decomposed at 450°, furnishing nitrous anhydride and a well crystallised sesquioxide, without any appreciable amount of nitrite being formed. The nitrite is decomposed in an analogous manner. It was found that thallous nitrate can be partly volatilised without decomposition.—The total synthesis of rhodinol, the characteristic alcohol of essence of roses: L. **Bouveault** and M. **Gourmand.** Ethyl geraniate, treated with sodium and absolute alcohol, gives a mixture of two alcohols, one of which is rhodinol. This alcohol possesses a strong odour of roses, and, except that it is inactive, shows all the properties of the rhodinol extracted from essence of roses and essence of pelargonium. A crystalline semicarbazone, melting at 112°, has been prepared from its pyruvate, and this has been found to be identical with the similar compound prepared from the natural rhodinol.—On two homologues of pyrocatechol: R. **Delange.** The preparation of ethylpyrocatechol and isopropylpyrocatechol is described, and their physical properties given.—On a new class of ether-oxides: Marcel **Descudé.** By the action of sodium ethylate upon dichloromethylether, the ether

$$C_2H_5—O—CH_2—O—CH_2—O—C_2H_5$$

is obtained. In its chemical and physical properties it approximates to the formals.—On methylarsenic: V. **Auger.** Solutions of sodium methylarsenate reduced by heating in the water bath with sodium hypophosphite give a yellow oil of the empirical composition CH_3As. This can be purified by fractional distillation in a vacuum, and cryoscopic determinations in benzene solution show that its molecular weight is four times that of the simple formula. It polymerises readily in presence of hydrochloric acid, giving a brown powder which has been mistaken for arsenic.—On some mixed phosphorus acids derived from hypophosphorous acid: C. **Marie.**—Additional ammoniacal compounds of the rosanilines: Jules **Schmidlin.**—Study of the variation of the mineral matters during the ripening of seeds: G. **André.**—Researches on plant acidity: Eug. **Charabot** and Alex. **Hébert.**—The action of heat and acidity on dissolved amylase: P. **Petit.** The diastatic power of a malt may be increased by altering the acidity of the solution to the point corresponding to coagulation by heat.—Abnormal developments independent of the medium: C. **Viguier.**—On an unknown animal met with in the Bay of Along: M. **L'Eost.** An account of an animal, apparently a sea serpent, seen from the gunboat *Décidée* on February 25. Its length was estimated at 30 metres.—The complete extraction of water and gases from seeds: Paul **Becquerel.**—A resonance method for the determination of the frequency of nervous oscillations: Augustin **Charpentier.**—On the urinary chromogen due to subcutaneous injections of skatol: Ch. **Porcher** and Ch. **Hervieux.**—The action of salts of the alkaline metals upon the living substance: N. C. **Paulesco.** The limiting quantities of salts of the alkalies which act upon yeast under fixed conditions are proportional to their molecular weights.—On the problem of "statical work": hydrodynamical and electrodynamical paradoxes: Ernest **Solvay.**—On the laws of the so-called "statical work" of muscle: Ch. **Henry.**—On the toxic action of intestinal worms: L. **Jammes** and H. **Mandoul.**—Observations at the Franco-Scandinavian captive balloon station at Hald: L. Teisserenc **de Bort.**

CONTENTS.

THURSDAY, JULY 14, 1904.

IS RADIUM AN ELEMENT?

Radio-activity. By Prof. E. Rutherford, F.R.S. Pp. viii + 399. (Cambridge: University Press, 1904.) Price 10s. 6d. net.

Radio-activity. By F. Soddy, M.A. (The *Electrician* Printing and Publishing Co., 1904.)

Radium. By L. A. Levy and H. G. Willis. (London: Percival Marshall and Co., 1904.)

IN February, 1896, M. Henri Becquerel found that uranium salts emit rays capable of affecting a photographic plate and of penetrating black paper and other bodies opaque to ordinary light. In the eight years which have elapsed since, a startling series of discoveries of extraordinary interest to the physicist and chemist has rewarded those experimental investigators who followed up the clue given by Becquerel's observation just mentioned. As the result of their labours, a new branch of physical chemistry has been created which already possesses a bulky literature, growing with ever-increasing velocity. The following are approximately the number of papers on radio-activity published in scientific journals for each year since Becquerel's original discovery:—1896, 7; 1897, 6; 1898, 7; 1899, 18; 1900, 39; 1901, 36; 1902, 41; 1903, 90. Thus at present the literature of the subject comprises several hundred papers, and new papers are appearing at the rate of several per week.

Among those who have contributed most to the exact study of radio-activity, Prof. Rutherford occupies a foremost place, so that a connected account of the experimental results obtained and theories proposed to explain them from his pen cannot but be welcomed by all those interested in the subject. The volume under consideration is the third of the "Cambridge Physical Series," edited by Mr. F. H. Neville, F.R.S., and Mr. W. C. D. Whetham, F.R.S. The first volume was "The Theory of Solutions," by Mr. Whetham, and the second "The Conduction of Electricity through Gases," by Prof. J. J. Thomson. The remarkably high standard of scientific excellence set by the first two volumes of the series is fully maintained by Prof. Rutherford in the third.

The first chapter contains an historical account of the discovery of the radio-active properties of uranium and thorium, of Madame Curie's magnificent discovery of radium, and of the discovery of the other less known radio-active elements. The second chapter contains a short account of the ionization theory of conduction through gases, on which so much of the work on radio-activity depends, and the third a very useful account of the experimental methods employed in investigating the properties of the radiations emitted by the radio-active substances. The remaining chapters contain a very complete and concise account of the nature of the radiations, of the amount of energy emitted, and of the remarkable atomic transformations of radio-active matter. The book is not of a popular character; it is intended for those who wish to study the subject scientifically, possibly with the view of undertaking research work on it. For such students it is admirably adapted, and possible openings for research work are suggested implicity or explicitly on almost every page. Such a work cannot fail to be of great service to scientific students.

The remarkable phenomena exhibited by the radio-active elements have led to the adoption of theories which a few years ago would have appeared almost ridiculous. One gram of radium gives out more than 800,000 gram calories of heat per year. This heat is apparently due to the spontaneous disintegration of radium atoms into matter possessing less energy. Radium is, in fact, an endothermic compound in process of decomposition. So far as we know the process is not reversible, but it may be that at extremely high temperatures radium atoms could be formed by the combination of their products of disintegration with absorption of heat.

The radium atom first emits an α-particle which is a positively charged body having a mass about twice that of a hydrogen atom. The rest of the atom constitutes radium-X. The radium-X then disintegrates into an α-particle, and the gaseous radium emanation, this in turn disintegrates, and the process goes on through a whole series of transformations. The final product is, it is suggested, perhaps polonium. A radium atom, therefore, appears to consist of a polonium atom, and about six α-particles. But there is reason to believe that the α-particles, when their charge is neutralised by a negative corpuscle, become helium atoms. If this is so, then a radium atom is really the compound radical $PoHe_6$, and is not an elementary atom at all. On the other hand, radium is from the chemical standpoint closely analogous to calcium, strontium, and barium, and it finds a place in the periodic arrangement of the elements. If, then, radium is really a compound radical, it is probable that all the other elements, except, perhaps, helium, and a few others of small atomic weight, are compound radicals also. The chemist must, in fact, either adopt a new definition of an element or else prepare for a large reduction in the number of such bodies.

The velocity of the radio-active processes is independent of the temperature. This remarkable fact is said to indicate that the changes taking place are of a purely atomic character. It must be admitted that the meaning of this statement is not very clear. If the radium atom consists of several parts which are separated during the process of disintegration, then the radium atom is really a molecule, and its disintegration is, strictly speaking, a molecular process. Moreover, molecular processes are known the velocity of which is independent of the temperature within certain limits. For example, the rate of solidification of many supercooled liquids increases at first with the supercooling, but then attains a constant value independent of the supercooling over a considerable range of temperature. The energy set free during radio-active processes is enormous compared with the kinetic energy of the molecules due to heat motions, and there is no known reason why such irreversible decompositions should not proceed at a rate independent of the temperature, even if they are not of a purely atomic character.

The rate of disintegration of the radio-active bodies is also independent of their state of chemical combination, which indicates that the radio-active properties belong entirely to the so-called atom of the radio-active element present, and are not communicated to the other atoms present in the compound.

It thus appears that the atoms of the so-called elements contain an immense store of energy, and this discovery leads to interesting possibilities which Prof. Rutherford discusses in connection with the heat supply of the sun and earth, and other heavenly bodies. If the sun and earth draw their heat-supply from this store, then it is possible that the present rate of emission may have been going on for vastly longer ages than those hitherto supposed possible, longer even than the ages demanded by geologists for the completion of the processes of formation of the earth's crust.

Exception may be taken to the terminology adopted in some parts of the book. For example, the product of decomposition of the radium emanation which is deposited on solid bodies is referred to as "emanation-X." It would probably be better to reserve the term emanation for radio-active gases; but at the same time, it must be admitted that "emanation-X" is a better name than "induced radio-activity."

The arrangement of the matter and its treatment are throughout admirable.

Mr. Soddy's book on radio-activity contains an excellent and interesting account of the subject. The arrangement of the matter and point of view adopted are very similar to those in Prof. Rutherford's book, of which Mr. Soddy's is practically an abridged and slightly popularised edition.

Messrs. Levy and Willis's book on radium is supposed to be of a popular character, and contains an account of many of the properties of radio-active bodies. The arrangement of the matter cannot be commended, and the authors' scientific knowledge does not appear to have been sufficient for the task they have undertaken. Facts and results which it is suggested might be obtained if looked for are mixed up in a manner calculated to confuse the reader; there are besides many inaccurate statements. It is difficult to see what useful purpose this book can serve.

HAROLD A. WILSON.

BOOKS ON PLANT-PHYSIOLOGY.

The Physiology of Plants, a Treatise upon the Metabolism and Sources of Energy in Plants. By Prof. W. Pfeffer. Second fully revised edition. Translated and edited by Dr. Alfred J. Ewart. Vols. i. (pp. xii + 632) and ii. (pp. viii + 296). (Oxford: at the Clarendon Press, 1900 and 1903.)

Vorlesungen über Pflanzenphysiologie. By Prof. Ludwig Jost. Pp. xiii + 695; with 172 illustrations. (Jena: Gustav Fischer, 1904.) Price 13 marks.

PROF. PFEFFER is to be congratulated on the completion of his great task—the re-writing, in the form of a second edition, of his well known "Pflanzenphysiologie." The present edition, of which the first instalment appeared in 1897, consists of what are practically three volumes containing some 1600 pages. Of these, the two first volumes are before us in an English translation.

The book is a unique one, for it is certain that none has ever appeared giving so complete an account of the physiology of plants. It must be remembered, too, that during the past forty years this branch of science has, through the labours of Sachs, Pfeffer, and a crowd of other workers, made great advances, and has developed into a huge mass of inter-related problems, so that the subject-matter is far more extensive than that which any previous writer has had to deal with. To form some notion of the activity of this department of botany, it is sufficient to look at the references which crowd the pages of the book.

It is perhaps owing to the mass of new matter which had to be incorporated that Pfeffer has somewhat condensed his presentment of general results. This has some disadvantages, inasmuch as the reader misses the give and take of a full discussion. He gets, it is true, the matured judgment of the author, but he gets it condensed to a somewhat dry and cold essence in which the quality of attractiveness is sacrificed. In what forms the main tissue of the book—the detailed consideration of experimental evidence—Pfeffer is at his best, and rules his armies of facts with the easy authority of one who is not only deeply learned, but experienced at first hand with every part of his subject.

The book follows the broad natural division of the subject into "Stoffwechsel" and "Kraftwechsel," that is, into one volume on metabolism—roughly speaking, nutrition—and two volumes on growth, movement and development. The most notable new feature in vol. ii. of the English edition is the prominence given to "causes of specific shape"; this change is the natural outcome of the recent increase of interest in this field of work, for instance in the researches of Vöchting, Goebel, Klebs, Driesch, &c. In consequence of the greater space given to this department (in itself a decided improvement in the new edition), the attention given to the special physiology of growth is relatively diminished as compared with the old edition. The volume also contains short discussions on heredity, variation, and allied questions. It is useful to know the author's views on questions of fundamental importance, but apart from this consideration we doubt whether these sections are quite worth giving in a book of this character, since it is impossible for the author to give space for an amount of discussion such as the problems demand. However this may be, and such points are largely a matter of individual opinion, on the main point there can be no doubt; no one can question the value of such a mass of information grouped in logical sequence, connected by the thoughts and criticisms of the leading plant-physiologist of the present day, and representing the mature result of a long life of strenuous and successful work.

Dr. Ewart, who has made the English translation, is well qualified for the work, being an accomplished physiologist, and his occasional remarks added in the capacity of editor are of value. The task of translating German requires a certain courage as well as

skill; the original sentences have to be individually annihilated before endurable English equivalents can be raised from their ashes. This Dr. Ewart has done so well that the book reads as though it had been written in English.

No one can nowadays write a physiological textbook without being largely indebted to Pfeffer's "Pflanzenphysiologie," and this, in his preface, Prof. Jost acknowledges in the fullest way; but his book is so different from Pfeffer's in scope and manner of presentment that it is essentially an original work.

It is an eminently readable and useful book; it is written in a clear and easy style, and steers a skilful course between some of the difficulties that beset the lecturer. On the one hand the author avoids placing too much stress on what is new, while he by no means neglects the recent literature, and is thoroughly up-to-date in his treatment of the subject. He is not afraid of facing a difficulty or of pointing out where our knowledge fails to solve the problem. He has produced a book admirably suited to the advanced student of an English university, and one that may also be read with advantage by more advanced workers. Jost's manner of stating his case is so suggestive, and he is so open in pointing to possible lines of inquiry, that the book cannot fail to be useful to a wide class of readers.

It is divided into three parts:—(1) Stoffwechsel, (2) Formwechsel, (3) Energiewechsel. Part i. deals with the absorption, transport, and loss of water, with the assimilation of carbon and nitrogen, and with respiration and fermentation. Under Formwechsel (part ii.) we have a general statement of the fundamental problems of development, then come growth and development under constant conditions. This is followed by the effects of the environment on growth, &c., and finally comes a section on periodicity, inheritance, and variation. Part iii. (Energiewechsel) deals with hygroscopic movements, growth-curvatures ("tropisms"), the movements of tendrils, of sleeping plants, &c., and chemotaxis, &c. The whole of part iii. seems to us particularly good, and contains much that is interesting and valuable in the way of discussion. We confidently recommend Prof. Jost's lectures, but since it is the duty of the reviewer to find some fault, we may direct attention to Fig. 141, which is printed upside down.

F. D.

CHRONOLOGICAL CALCULATIONS.

Astronomical and Historical Chronology in the Battle of the Centuries. By William Leighton Jordan, F.R.G.S., F.S.S., &c. Pp. 70. (London: Longmans and Co., 1904.) Price 2s. net.

THE main object of this little work is to contend that what is sometimes called the "astronomical" method of dating events prior to the Christian era is really what was intended to be used when the system of using dates before and after the birth of Christ was first introduced. Hence it is dedicated to the librarians of the cities of Florence and Pisa, in the hope of receiving from some of them "further evidence for the elucidation of the subject."

Now divisions of this kind involve the drawback of necessitating a reckoning in two directions. This is also the case, for instance, in the centigrade division of the thermometric scale, which is nearly always avoided by the general public in this country, and would be still more in countries which are nearer the equator, by using Fahrenheit's scale, the zero being below the lowest point usually reached in winter, so that a statement of the reading is sufficient, without adding above or below freezing, as the case may be. In dating an event, too, by Christian chronology, we have to state whether it occurred before or after the birth of Christ (or the year accepted as such), which is indicated by affixing the letters B.C. or A.D. But there is this further complication, as compared with a thermometric or other scale, that a degree is a definite point, and everybody knows that 1° below freezing is two degrees below 1° above it. A year is not a definite point of time, and we all know (having had a recent instance of it) what perplexity is caused in many minds when a new century has commenced with regard to which is the first year thereof. Our author reminds us, for instance, how the German Emperor insisted that the present (twentieth) century began at the beginning of the year 1900. A further complication is contained in the fact that we do not know exactly the date of Christ's birth.

But although that question is very interesting from an historical point of view, it is too late now to treat of it as a matter affecting our system of chronology. This is based on the assumed fact that the traditional date of the birth of Christ is the end of the year B.C. 1, so that one year after it was completed at the end of A.D. 1, a century at the end of A.D. 100, nineteen centuries at the end of A.D. 1900, and the twentieth century commenced on January 1, A.D. 1901.

Some people not versed in chronological calculations fancy that astronomers go out of their way to differ from ordinary people when they call the year which is commonly reckoned B.C. 1 (the year preceding A.D. 1) 0, and denominate B.C. 2 as the year − 1. But there is no such affectation of singularity in the matter; a necessity is laid upon the computer in this respect, for if we subtract 1 from 1, the result cannot be anything but 0, and if we subtract 2 from 1, the result must be −1. It is necessary, therefore, to remind ordinary people that if they desire to estimate the number of years from a date in B.C. reckoning to one at the same season in A.D. reckoning, it is not sufficient to add the years together, but unity must be subtracted from the result; from June 1, B.C. 10, for instance, to June 1, A.D. 10, is an interval of not twenty, but only nineteen years.

The author of the work before us desires to prove that those who first used Christian chronology intended that it should be reckoned in this way, the numbers being not cardinal, but ordinal. However, that is a mere matter of curiosity. An inmate of a lunatic asylum, who appeared sane to a visitor, was once asked why he was there. "Oh," he said, "I thought everybody else was mad, and they thought I was; as they were in the majority, they had their way with me, and so I am here."

The majority, in fact, must in all such questions have their way, and the existing system of chronology and its zero point (the end of B.C. 1 or of the year 0 reckoned astronomically) now so extensively pervade all history that they cannot be displaced. As regards the real date of the event on which they are nominally founded, that is another question. It seems clear that Herod the Great died in the spring of 750 by the years of Rome, corresponding to B.C. 4, and that our Lord was probably born towards the end of the preceding year, B.C. 5. Mr. Jordan refers (p. 28) to the proposal to put it back two years further, to A.D. 7, but as that theory is founded on Kepler's suggestion (which cannot be accepted) that the Star of Bethlehem was in fact a conjunction of planets, it may be dismissed as quite untenable. All who have studied mediæval writers on this subject are aware that the original proposal was to date, not from the birth, but from the incarnation of Christ, *i.e.* the Lady Day preceding the nativity; but that was soon merged in the other, which in fact superseded it. We must remind our author that astronomers when making chronological calculations do not call the vulgar era 5 B.C. (for instance) 4 B.C.; they call it A.D. -4, in the ordinary mathematical form when on the other side of the zero point.

It should be added that the book contains some interesting discussions respecting the first use of Christian chronology (superseding the era of Diocletian) and the early cycles used in the determination of Easter. In the application of a cycle there has to be taken into account not only its degree of accuracy (which is only approximate), but the date from which its use has been commenced. It is often forgotten what a twofold operation the Gregorian reformation involved; this, however, was gradually accepted in its entirety in the western church. W. T. L.

TOTEMISM AND EXOGAMY.

Social Origins. By Andrew Lang, M.A., LL.D. *Primal Law.* By J. J. Atkinson. Pp. xviii+311. (London: Longmans, Green and Co., 1903.) Price 10s. 6d. net.

MR. LANG'S critical genius has done great service to anthropology and the science of religion, and the present work, both in its criticism and constructive theory, definitely advances the study of primitive marriage and social organisation.

The essay on "primal law" deals with the origin of exogamy, and may be considered first. Its author, the late Mr. J. J. Atkinson, spent most of his life in New Caledonia, and knew the natives well. His theory, therefore, merits our careful consideration. He takes man in the semi-brutal stage, before language was evolved living, as Darwin thought, not in hordes, but in small unsocial groups, each composed of one adult male with several wives and children. The sons of such a family would be expelled as soon as they reached maturity, owing to the fierce sexual jealousy of the father. This picture is based on what we know, little enough, of man-like apes, such as the gorilla; rightly or wrongly, evidence from cattle and other herding animals is also employed. Such, at least, according to the author, is the genesis of exogamy. He explains the well known avoidance customs between mother and son, brother and sister, as the result of the "primal law," finding a corroboration of his main point in the absence of avoidance between father and daughter. In his account of the further development he is not so successful. The theory, as a whole, is a striking one, and will have to be reckoned with, especially by those who believe in the "horde" as the first form of social organisation, and in communal "marriage" as the original type of union. We are taken so far back in the evolution of man that savage analogies can hardly be applied, and here our difficulties begin. What are the conjugal habits of the higher animals generally, and of the anthropoid apes in particular? Can zoologists give us further evidence beyond the few and possibly doubtful facts hitherto observed on which the theory is based? Another difficulty is the psychological question. We can understand *proprietary* jealousy, and an exclusion of *potential* rivals, both marital and patriarchal; but the sexual instinct of animals in a natural state is as absolutely regulated and free from excess as is that of the normal savage. With regard to the absence of avoidance in the case mentioned above, I am informed by Mr. A. W. Howitt and Prof. Baldwin Spencer that there is no evidence in Australia of such a practice as it would imply. Lastly, one is inclined to suspect single-key theories.

Mr. Lang discusses exogamy, as defined by M'Lennan, and the origin of totemism. With his usual acuteness, he fixes on essential points. In the question of exogamy, an essential phenomenon is the bisection of a tribe, as commonly in Australia, into two exogamous intermarrying moieties, which contain totem-kins; of this a luminous explanation is offered. An exogamous tendency, of whatever origin, is presupposed; then an exogamous local group, which, after the institution of totemism, finds itself composed of variously named units, owing to the presence of alien women, agrees to intermarry solely with another community similarly composed. Such is the origin of the dual phratry system. This explanation is directly opposed to the prevalent view that the bisection was deliberately arranged at a mass meeting of the primitive horde, which had at last discovered the ill effects of promiscuity. But Mr. Lang himself is bound to admit some deliberate grouping of the totems, for we never find the same in both phratries. A final theory might be expected to supply an automatic reason for this result. A more important difficulty, to my mind, is the arrangement of *connubium* between the two local groups; it does not seem clear enough why so many tribes should owe their origin to a *dual* matrimonial alliance.

The explanation of the origin of totemism is suggested by the practice, found in English and French folk-custom, and paralleled elsewhere, of "blazoning" neighbouring villages with sobriquets, which are frequently animal names. The evidence cited on this head is very interesting, and the essential fact has emerged that totem names are *group names given from without.* When accepted, they would be invested

in time, through the action of superstition and myth, with a religious garb, and thus the marriage system would come under their influence. The theory seems to me very nearly, if not quite, to solve the mystery of totemism. There is also some good criticism of recent views, such as the origin of totemism from the "external soul," or from magical cooperative societies for the control of food.

The value of the book is increased by a clear exposition and sane criticism of the chief theories and suggestions which have been put forward in the study of totemism, exogamy, and primitive marriage.

ERNEST CRAWLEY.

OUR BOOK SHELF.

Immune Sera. Haemolysins, Cytotoxins, and Precipitins. By Prof. A. Wassermann, M.D. Translated by Charles Bolduan, M.D. Pp. ix+77. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.)

THE subject of immune sera has not in this country received as much attention from the medical profession as its importance and interest deserve. This is not so much due to the inherent difficulties of the subject as to the complicated way in which it has usually been expounded, and to the fact that the nomenclature introduced by different authors and experimenters has been found bewildering. The difficulties have been increased by the introduction by various experimenters of different terms for the same entities, and often ones which suggest the function or properties of the substance, according to the inventor's particular views.

This neglect is the more to be regretted, as investigations upon hæmolysins, cytotoxins, and precipitins which at first seemed to possess merely scientific interest, have become of the greatest importance, owing to the close analogy which has been found to obtain between these phenomena and those of natural and acquired immunity. These studies have indeed occupied an important and striking position in the development of our knowledge of the mechanisms whereby an animal protects itself, or is protected, against the invasion of the micro-organisms of infectious diseases.

This little book of seventy-five pages is an English translation of one of the "Clinical Lecture" series, edited by von Bergman. The treatment of the subject is intended for medical men generally, and is not addressed to specialists. That Prof. Wassermann is the author is sufficient guarantee that the matter has been judiciously selected, and the manner in which it is presented could hardly be improved upon, so that it forms a clear and interesting account of the subject. The main facts and principal conclusions, including a brief but adequate *résumé* of Ehrlich's development of his side-chain theory to apply to anti-bodies in general, are given, but all unnecessary controversial matter is omitted. At the end is a very select bibliography, to which the reader is from time to time referred for fuller information.

The translation is excellent, and we confidently recommend this little book to the attention of all medical men, or others, desirous of acquainting themselves with the essential and most significant facts on the subject of immune sera.

CHARLES J. MARTIN.

The Flora of the Parish of Halifax. By W. B. Crump and C. Crossland. Pp. lxxiv+316. (Halifax Scientific Society, 1904.) Price 10*s*. 6*d*. net.

THE question arises, Why should the records of a parish be amplified into a book containing 300 odd pages? in reply to which the authors explain at the outset that the parish of Halifax covers 129 square miles, and corresponds to a natural geographical division, through which flows the River Calder. But although the area is circumscribed and the vertical range is not great—the altitude varies between 500 and 1500 feet—the number of plants found within the district forms a good list, which has been worked up into an attractive historical and ecological account, and in addition, owing to the cooperation of other workers, it has been possible to include lists of all the cryptogamic plants. Looking at the plant associations, the mixed deciduous woods are the habitat of the globe-flower, the bird's nest orchid, the helleborine and the daffodil, while among the rare species of the heather moors are reckoned the bog-bell, the winter greens, and the bear berry. The bryologist, too, will find a good hunting ground, for, in addition to a fairly rich flora, the parish has yielded a new variety of Philonotis, the first record in Yorkshire for *Amblystegium Juratzkae*, and one of the few stations in the British Isles for *Jubula Hutchinsiae*. With the botany of Halifax is inseparably bound up the name of John Bolton, painter and naturalist, who in 1785 published "Filices Brittanicæ," with thirty-one copper plates all drawn by himself, and in 1791 completed "An History of Fungusses," also provided with plates, and the extent of his collections can be gauged from the numerous records which are given in the book.

While this "Flora" must naturally prove most useful to those who can traverse the parish, the ecological account and the records will serve for guidance and reference to a larger number of naturalists.

Chemisches Praktikum. By Dr. A. Wolfrum. II. Teil. Präparative und Fabrikatorische Übungen. Pp. xii+580. Price 15*s*. net. Atlas, Part ii. Atlas, price 1*l*. net; together, price 1*l*. 8*s*. net. (Leipzig: Engelmann, 1903.)

WE gather from the preface to the first part that the author's intention in compiling this work was to present the student whose aims lie in the direction of chemical technology with a course of practical exercises especially fitted for his future career. The first volume dealt with analytical work, and here the student is introduced to preparative chemistry.

The first chapter is devoted to a discussion of general matters, such as the treatment of materials for preparative and technical purposes, the general conditions of chemical reaction, and the separation, purification, and testing of reaction products. In the second chapter of 150 pages, the methods of preparation of a large number of inorganic and organic substances are described. Fifteen pages form the third chapter, which deals with the dynamics of chemical reactions, and the last two chapters are devoted to matters of a specially technical nature—descriptions of furnaces, autoclaves, filter-presses, air-pumps, condensers, centrifuges, &c., the fitting up of factories, book-keeping, patent laws, and, finally, exercises in connection with large scale technical processes are given.

Such is the programme arranged by the author for the future works chemist. It must be admitted that in many cases the practical courses provided at the universities and higher technical institutions for such chemical students might be with advantage considerably modified; in most cases the chief difficulty confronting such change is to be found in the greatly increased cost of laboratory equipment and upkeep. Without such equipment it is questionable whether the "Chemisches Praktikum" can be advantageously used by the technical student. The preparations are well chosen, but the working details would have been far more intelligible to the average student if

occasionally illustrated by diagrams of the apparatus employed.

What benefit the student will be able to derive from the technical chapters can only be decided by experience. The value of these is undoubtedly enhanced by the supplementary album containing some 560 excellent diagrams illustrating technical apparatus and actual manufacturing processes. Amongst other processes illustrated are the manufacture of liquid ammonia, liquid carbonic acid, chlorine, ether, aniline, hydrochloric, nitric, sulphuric, tartaric, citric, and carbolic acids. A careful study of such diagrams cannot but be of great service to all intending works chemists.

The Personality of the Physician. By Dr. Alfred T. Schofield. Pp. x+317. (London: J. and A. Churchill, 1904.) Price 5*s.* net.

As with all the writings of Dr. Schofield, this present work shows indubitable signs of wide reading and of careful thought.

The underlying gist of the matter is that the most potent factor in a physician's success is the personal equation. Of course, by the word "success" Dr. Schofield does not mean what is sometimes profanely styled "scooping in the shekels"! Nor does he fail into the very common error of confusing *personality* with *prestige.* The latter may, of course, be shared with the physician, who aspires to occupy the most lofty possible pinnacle of moral excellence, by the lowest and most unprincipled charlatan.

Happily, the ethical standard, recognised by the medical profession in this country, is of the highest conceivable type. Nevertheless, any publication that tends to raise, rather than to level down, that ideal is very rightly welcomed alike by the profession, by the Press, and by the people at large.

Some medical men are more comforting than others, and it is quite certain that pessimism more surely empties the consultant's waiting-room than any other quality. If the reviewer, who yields to no man in his admiration of the noblest of all professions, might be for once pardoned for a little private grumble at some of the physicians with whom he has come in contact, it is because of the grudging manner in which certain doctors, otherwise worthy and excellent men, deal out with sparing hand a remedy—Tinctura Spei—which costs them nothing, and yet is probably the most valuable drug ever dispensed!

Rustless Coatings: Corrosion and Electrolysis of Iron and Steel. By M. P. Wood. Pp. x+432. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 17*s.* net.

MR. M. P. WOOD may be a good "practical" man, but he has neither literary ability nor a knowledge of science sufficient to enable him to do justice to a subject which demands much more than rule-of-thumb practice to deal with it adequately. His book is a strange medley of so-called scientific statements strung together without any real acquaintance with their meaning. Its appearance of scientific erudition may serve to deceive the unwary, and we quite agree with Mr. Wood that there is much in paint and in things connected with paint that *is* calculated to deceive the unwary. But then something depends upon the guide. Mr. Wood's book is very prettily got up, and some of the illustrations are in the highest style of process-art. But like much of the subject-matter, many of them are wholly irrelevant. Mr. Wood has evidently had the ambition to make a book on a subject with which as a practical man he has been more or less intimately connected, but in this matter his ambition has overleaped itself.

Ankauf, Einrichtung und Pflege des Motorzweirades. By Wolfgang Vogel. Pp. xiii+144. (Berlin: Phönix-Verlag, 1904.) Price 2.65 marks.

ANYONE who possesses a motor bicycle or tricycle and can read the German language will find in these pages much valuable information in the form of practical suggestions as to the buying, working, and maintenance of these useful means of locomotion. The author deals fully with every part of the machine, and illustrates the text with numerous drawings which should very much assist the novice in understanding the functions of the various parts of the machine. The great improvement in design of motors, and the growing popularity of this form of transport, will no doubt call for many small treatises on the subject, of which the present one is an excellent example.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Origin of Radium.

APROPOS of Mr. Strutt's letter in NATURE of July 7, it may be recalled that the Curies found that the artificially prepared chalcolite (the uranium copper phosphate) contained no radium, whereas the natural substance did.

It appears to me that if this fact is considered along with Mr. Soddy's result as to the failure of uranium nitrate to generate radium, the *prima facie* interpretation would be that the combined copper atom was in some way concerned. Of course the alternative view is still left that it takes a longer time than elapsed in Mr. Soddy's observations for radium to emerge from a succession of changes taking place in the uranium atom, and that this atom is the sole parent. However, in the present state of our knowledge it seems worth investigating if it may not turn out that radium results from the convection of ions from atoms of higher to atoms of lower atomic weight, producing in radium an unstable or overcharged atom.

On these grounds I have recently induced my friend Mr. Emil Werner to prepare about half a kilo. of the uranium mica or chalcolite with the view of testing at intervals its yield of radium emanation, if any is, indeed, generated. Along with this will be observed the pure uranium nitrate as well as an impure uranium nitrate recrystallised with small quantities of some of the heavy metals. My experiments are on rather a small scale. It is desirable, I think, that they should be repeated by some one commanding larger resources.

J. JOLY.

Trinity College, Dublin.

Electric Wave Recorder for Strutt's Radium Electroscope.

THE periodical discharges of a Strutt's radium electroscope can be arranged to ring a bell or print a record of every contact of the leaves; each discharge from the outside terminal, when the leaf strikes, is sufficient to act on a coherer, if any part of the coherer circuit is connected by wire, so that the discharge terminal of the vacuum tube takes the place of the aërial, as used in wireless telegraphy; the experiment never fails, every discharge producing a ring on the bell or a dot on the Morse tape as desired. For the coherer I use two pieces of No. 16 German silver wire, with nickel filings in the gap, at ordinary atmospheric pressure.

It is sometimes possible to get the coherer to respond by induction without metallic contact with the terminal, but this is rather beyond the sensibility of the apparatus employed.

I am greatly indebted to Dr. W. H. Martindale for the loan of his Strutt's radium electroscope for use in these

experiments; the performance of this instrument is very fine; the quantity of radium enclosed is nearly 3 milligrams; this produces a discharge at intervals of about 70 seconds—this rate is not in any way altered by attaching the coherer and apparatus. F. HARRISON GLEW.

156 Clapham Road, S.W., July 1.

THE MEMORIAL TO SIR GEORGE STOKES.

ON Thursday last, July 7, the memorial to Sir George Gabriel Stokes was unveiled in Westminster Abbey by the Duke of Devonshire in his capacity of Chancellor of the University of Cambridge.

The initial steps for the erection of this memorial were taken at a joint meeting of representatives of the Royal Society and the University of Cambridge, held in the Royal Society's rooms on March 12, 1903, when a committee was constituted to devise measures for providing a public memorial to commemorate the scientific career of Sir George Stokes and to take steps for carrying the project into effect. On that occasion it was decided to send a letter, in the names of the Chancellor of the University of Cambridge and the president of the Royal Society, requesting the authority of the Dean and Chapter of Westminster to place a memorial in the Abbey in the form of a medallion relief portrait of Sir George Gabriel Stokes, of the same general character as the memorials of Charles Darwin and other scientific men now in the Abbey. At the same time a subcommittee was formed to collect subscriptions for the purpose in view, and for carrying out the resolution of the full committee. In response to the committee's application the Dean gave his assent to the proposal, and agreed to take detailed plans into consideration. The subcommittee consequently, in consultation with the Dean, offered a commission to Mr. Hamo Thorneycroft, R.A., to execute a medallion.

The ceremony on Thursday was preceded by a meeting, in the Jerusalem Chamber, of subscribers to the memorial, and personal friends of Sir George Stokes. The meeting was presided over by the Dean, and was attended by many distinguished men of science and of letters. The Dean was supported by the Duke of Devonshire, Sir William Huggins, president of the Royal Society, Lord Kelvin, Lord Rayleigh, Prof. Larmor, and Prof. Forsyth (honorary secretaries to the memorial fund), and Mr. Kempe, treasurer of the Royal Society. There were present also the American Ambassador, Mr. Bryce, Sir William Crookes, Prof. George Darwin, Sir James Dewar, Sir Joseph Fayrer, Principal Carey Foster, Mr. Francis Galton, Sir John Gorst, Prof. Liveing, Sir Norman Lockyer, Sir Andrew Noble, Dr. Thorpe, and many other fellows of the Royal Society.

Prof. Larmor read letters from the Prime Minister, Lord Lister, Sir Joseph Hooker, Sir Michael Foster, Lord Goschen, Lord Avebury, and others expressing regret for their unavoidable absence.

The Dean opened the proceedings, and prefaced his remarks by directing attention to the increasing difficulty of finding space within the Abbey for such memorials as that which they were met to dedicate. He stated the history of the movement described above, and referred to the wonderful trio of famous senior wranglers occurring in successive years, Stokes, Cayley, and Adams, followed two years later by Lord Kelvin, and enlarged upon Stokes's lofty personal character, his peculiar greatness of mind, his generosity, and his humility. The Dean regretted the impracticability of devising a motto for the memorial tablet which could with sufficient terseness express the comprehensive range of Stokes's genius.

The Dean then called upon Sir William Huggins, president of the Royal Society, who, after referring to the part the Royal Society had taken in the movement for the memorial, spoke of the great services rendered to the Royal Society by Sir George Stokes during his thirty-one years' tenure of the secretaryship of the Society and his subsequent five years' occupancy of the presidential chair. Sir William referred to the wide range of Stokes's discoveries and particularly to the great advances which he made in the application of mathematics to physics. He extolled the wonderfully even balance of his powers and his remarkable soundness of judgment, and contended that his influence on his time was due as much to his greatness of character as to his intellectual accomplishments. He therefore held him worthy of a shrine by the side of Newton, Herschel, Darwin, Adams, and Joule.

Lord Kelvin described in some detail, and eulogised the great range and broad aspect of Stokes's work in science, and pointed out how fruitful it had been of great developments in recent times. He referred to his investigations upon elasticity, his paper of 1850 upon water waves, his researches in light and optics, and particularly to his discovery of fluorescence; and reminded his hearers that Stokes's work and thought are but partially represented by his published writings. He recalled the indebtedness of many authors of scientific papers to Stokes for aid and illumination received from him during his long secretaryship of the Royal Society, and in feeling terms referred to his own relations with Stokes, saying, "For sixty years of my own life I looked upon Stokes as my teacher, guide, and friend. His death was for me truly a bereavement."

Lord Rayleigh, speaking as a pupil of Sir George Stokes, described his experiences as a student at his lectures, and the unbounded admiration he always felt for him as a teacher, a man, and an investigator. He held up as an example still to be followed the simplicity of Stokes's experimental methods and his limitation of his apparatus to the bare essentials for the demonstration of the principles he was expounding. Lord Rayleigh referred more particularly to some experiments and investigations of Stokes, including those on the spectrum of the blood, on the theory of spectrum analysis, and to some of his incidental papers on acoustics, and said that Stokes's papers, whether mathematical or physical, or both, were always interesting to read.

The Vice-Chancellor of the University of Cambridge, speaking on behalf of the University, welcomed the honour done to Stokes's memory by this memorial. He paid an eloquent tribute to his great character, to his loyalty and affection for his university and college, and said that the university rejoiced that his name would now have a permanent memorial on the historic walls of that great national church.

The company then proceeded to the Abbey, where, after a prayer from the Dean, the Duke of Devonshire removed the cover from the medallion, which hangs on the wall with those of Adams and Darwin in the north aisle of the choir of the Abbey.

The Duke of Devonshire said, "Speaking on behalf of the subscribers, I offer this medallion to be added to the memorials and to be preserved in the Abbey church."

The Dean responded, "Speaking in the name of the Dean and Chapter of Westminster, I accept this medallion to keep and preserve among the memorials of the good and great men in this place."

The memorial is in the form of a bronze medallion, with a portrait head of Sir George Stokes in very high relief, and bears the inscription, "George Gabriel Stokes, 1819–1903."

A STORY OF THE PHILIPPINES.[1]

MOST people, after reading the latest work of that indefatigable traveller Mr. Savage Landor, will be disposed to question the appropriateness of his title "Gems of the East." Beyond the attraction of remoteness (which always possesses a fascination for the explorer), and the interest which still lingers round the records of the American occupation of those islands, there does not appear to be much in the humid, swamp-ridden plains, or in the volcanic hills of the Philippines to justify the suggestion of entrancing glitter and brightness; even if it justifies the production of two volumes of statistical detail about them.

FIG. 1.—Woman carrying Water in a Bamboo Cylinder. From "Gems of the East."

In some respects this latest of Mr. Landor's works differs essentially from its predecessors. There is far less effort to maintain the interest of the reader by a narrative of perilous adventures and hairbreadth escapes, and much more appeal to the student of science generally, and of anthropology in particular in which branch, indeed, Mr. Landor shows himself to be an expert. So far, perhaps, the author is to be congratulated, for there must certainly be amongst his assortment of observations on subjects geological, botanical and ethnographical, or purely anthropological, many which are new to science, and therefore valuable. Nor are the incidents of adventure by any means wanting. There is room in the book for new records of perils by land and sea—adventurous rock-climbing, rough and ready campaigning with American troops, coast exploration, collisions with cannibals and head hunters, &c.—which recall the exploits of the Savage Landor of Tibet and Baluchistan; but they are no longer the mainstay and objective of the work.

The present book contains far more of patient and honest scientific research than of those fantastic performances as an explorer which have made Mr. Landor famous. His manner of writing is familiar and colloquial, occasionally almost ungrammatical. Taking the reader by the arm (metaphorically, for he is careful to explain that he always travels alone), he leads him gently to the outermost verge of civilised existence, and there introduces him to a race of people scattered in innumerable tribes through the islands of the Philippine group, who are so little understood, even by their American administrators, as to be amongst the most interesting of those aborigines of humanity who are still left struggling against the world-swamping waves of civilisation. They will doubtless "go under"—absorbed by the spread of those growing and expanding nations who will finally reduce the ethnographical conditions of the world to one dead level of uninteresting development. Judging from Mr. Landor's description of the countries which they occupy, and of the advance of American institutions amongst them, it will probably be long yet ere the Philippines assume a social condition analogous to that of Cape Colony or of India; but the process is none the less sure because it is slow. Mr. Landor is naturally charmed with the Americans whom he met in the Philippines, and some of the best chapters in his book are those which recount the familiar story of administrative difficulties and of tribal resistance,

FIG. 2.—Bontoc Igorrotes: showing resemblance to Ainu of North Japan. From "Gems of the East."

[1] "Gems of the East." By A. Henry Savage Landor. Pp., Vol. i., xii+328; Vol. ii., xi+460. (London: Macmillan and Co., Ltd., 1904.) Price 30s. net.

drifting finally into armed expeditions and the reduction of native strongholds.

American pluck and endurance are fully tested in these little frontier wars, which afford opportunities for the practical training of soldiers such as are rapidly disappearing on the borderland of the continental Red Indian. Cholera appears to be their deadliest foe in the field, allied to certain forms of local disease the exact nature of which is not readily recognisable from Mr. Landor's description. The author has no high opinion of modern medical science. The Filipinos (he tells us) are not yet foolish enough to believe in the mosquito theory for malaria. Nevertheless, they build their houses on piles so as to raise them sufficiently above the humid atmosphere of the ground level to ensure a free current of air. Nor does he himself believe in the efficacy of boiling water in order to render it free from germs and choleraic impurities. Precautions of any sort, indeed, do not appeal to his spirit of chivalrous adventure. When climbing precipices "I did not use ropes or other such nonsensical Alpinistic devices; my rule has always been to use common sense and avoid all accidents." This certainly is an excellent rule (if not entirely original), and one much to be commended to the Alpine Club. But combined with a proud disregard for such conventional appliances and precautions as usually become more valued by the geographical explorer the farther his experiences extend, Mr. Landor undoubtedly possesses that great faculty of human sympathy which enables him to deal with all classes of people, and to obtain the confidence (even the cooperation) of the aboriginal natives in branches of research which must have appeared to them exceedingly strange and suspicious. It is most difficult to persuade the brawny independent savage of the jungle to permit himself to be handled and measured, to have calipers applied to his head, and a minute examination made of all the features which nature has given him, for a purpose which is absolutely unintelligible to his limited understanding.

But Mr. Landor succeeded admirably, and the result is undoubtedly a valuable contribution to anthropological science, although the constant repetition of tables of measurement might very well have been dispensed with in a book which (regarded as a popular work) is already too long.

The multitude of the islands forming the Philippine group, and the excessive variety of detail which permeates them, the differentiation between the many tribes which inhabit them, and even the enumeration of their extraordinarily abundant vegetable products, become confusing after a while, and it is a relief to turn to the story of pure adventure, and the occasional interludes of graphic description, which is what the world looks for from Mr. Landor's pen. Doubtless it is Mr. Landor's intention to pose seriously as a scientific observer, and there is quite enough in the book to justify the assumption; but it might have been better had he made a little wider separation between that which belongs to the realm of statistical detail and that which is narrative of personal adventure.

T. H. H.

A PROBABLE CAUSE OF THE YEARLY VARIATION OF MAGNETIC STORMS AND AURORÆ.

IN a previous number of this Journal (vol. lxvii. p. 377) an account was given of the very close relationship which seemed to exist between the epochs of the occurrence of prominences in the polar regions of the sun and Ellis's "great" magnetic disturbances. In a later number (vol. lxviii. p. 257) it was shown that the presence of these polar prominences synchronised also with the appearances of large "polar" coronal streamers as seen during total solar eclipses. Disturbances near the solar poles seemed to play such an important *rôle* both in solar and terrestrial changes that an inquiry was made to find out whether any effect is felt on the earth when either of these solar poles is turned towards the earth during the course of the year. The result of such an investigation, recently communicated by Sir Norman Lockyer and the writer to the Royal Society, will here be briefly stated.

During the course of a year the south pole of the sun is most turned towards the earth in the beginning of March, and the north pole most towards the earth in the beginning of September. At the two intermediate epochs, in the beginning of June and December, neither pole is turned towards or away from the earth, but occupies an intermediate position. Hence we see that the *equinoxes* occur in the same

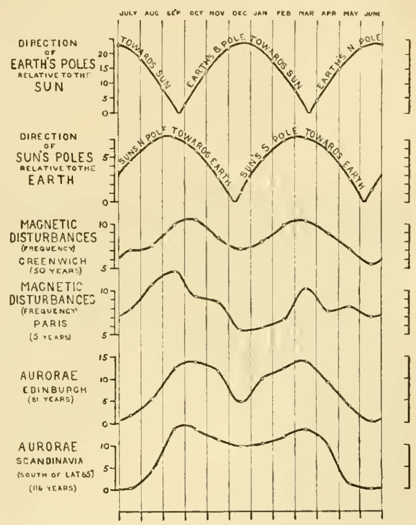


FIG. 1.—Curves showing the relationship between the positions of the earth's poles in relation to the sun, the sun's poles with regard to the earth, and the frequency of magnetic disturbances and auroræ throughout a year.

months as those in which one or other of the solar poles is turned towards the earth, while the neutral positions of the solar poles in relation to the earth occur in the same months as the *solstices*.

If, therefore, these solar polar regions are capable of disturbing the magnetic and electric conditions on the earth, then, when they are most directed to her at the equinoxes, the greatest effects during a year should be recorded, and when they are least directed the effects should be at a minimum.

With regard to the facts about the variation of magnetic disturbances and auroræ, Mr. Ellis has shown that the curves of frequency of magnetic disturbances at Greenwich and Paris are very similar, "showing maxima at or near the equinoxes, and minima at or near the solstices." These also, he further points out, are similar, with regard to the epochs of maxima, to the curve representing the

frequency of the aurora at London. In the case of auroræ observed in Edinburgh, north-east Scotland and in different regions in Scandinavia, the months in which the greatest frequency is recorded are September and October (perhaps more generally October) and March and April (perhaps more generally March).

The accompanying figure (Fig. 1) shows in a graphical form the annual variation of these magnetic and auroral frequencies, indicating their epochs of maxima and minima. Above them are the curves showing (at the top) the epochs when the *earth's poles* are turned towards the sun (the origin of our seasonal changes) and (below) when the *sun's poles* are turned towards the earth.

The coincidence in time between the epochs of the maxima of the frequency of magnetic disturbances and auroræ, and those of the greatest inclination towards the earth of the north and south solar polar regions can thus be seen at a glance.

The inquiry was pursued further to find out whether this yearly inequality of these terrestrial magnetic disturbances was influenced differently according as the sun's polar regions were, for several groups of years, in an undisturbed or disturbed condition.

It was expected that the oscillation of more disturbed solar polar regions towards and away from the earth would tend to *increase the difference* between the frequency of magnetic disturbance at the equinoxes and solstices, while this difference for those years when the less disturbed solar polar regions were in action should be somewhat *reduced*.

It was shown in the paper that this is actually the case, the frequency of the magnetic disturbances at the equinoxes being in greater excess over the solstitial frequency the greater the degree of disturbance.

There is thus reason to believe that the orientation of the solar poles with regard to the earth is the origin of these magnetic and electric annual changes.

WILLIAM J. S. LOCKYER.

THE ORNITHOLOGIST IN LAPLAND.[1]

RUSSIAN Lapland, although it has its charms during the brief summer, cannot be described as a desirable country, either for residents or tourists, since, except in a few sheltered spots, it produces little fodder save reindeer moss, while the fishing and shooting are but indifferent, and in late seasons the ground may remain covered with snow until well into June. Moreover, almost as soon as summer has set in, mosquitoes of a particularly vicious kind make their appearance in swarms, and render life well-nigh intolerable in the marshy districts which form the greater part of the country. When to these drawbacks are added the difficulties of travel, both by sea and land, there is little wonder that northern Lapland attracts

FIG. 1.—Driftwood on Beach, Kanin. From Pearson's "Three Summers among the Birds of Russian Lapland."

[1] "Three Summers among the Birds of Russian Lapland." By H. J. Pearson. Pp. xvi+216; illustrated. (London: R. H. Porter, 1904. Price 21s. net.

but few tourists. Nevertheless, to the ornithologist and the egg-collector it is little short of a paradise, birds of many kinds resorting to its inhospitable shores for the breeding season in vast numbers. The variety and abundance of bird-life are, indeed, testified by the statement of the author of the handsome and exquisitely illustrated volume before us, that during his first trip he encountered no less than seventy-six species, of forty-four of which he succeeded in obtaining the eggs. This exuberance of bird life the natives do their best to keep in check, and it must be confessed that a bird protection society would find plenty of scope in the country, as all birds large enough to be eaten are shot during the breeding season, while the eggs of many species are taken by the thousand. An excuse for these practices is to be found, as the author states, in the circumstance that birds only visit this part of Lapland in order to breed, and if they did not do so then, the natives would never have a chance of killing them at all. Loons, or divers, it appears, are often taken accidentally in fishing nets, but puffins, which swarm in the country and have been described in an official publication as "ducks," are taken for food by stretching old nets across their holes.

Previous to the first of the three trips recorded in this volume, Mr. Pearson had already visited Lapland, and has described his experiences in "Beyond Petsora Eastward." Of the three trips described in the present work, the first was undertaken in 1899, and was devoted to the exploration of the northern districts of the country; in 1901 the author visited the Kanin Peninsula, while in 1903 he penetrated the interior of the country south of Kola. The year 1899 was remarkable for the late melting of the snow, which still covered the country on June 2, when the herring-gull was found nesting on little patches of clear ground in the snow. During this year the starling seems to have first extended its range into the country, the species being at that time quite unknown to the natives. Among the larger birds, white-tailed eagles were found to be not uncommon, although, owing to the rewards offered by Government for their eggs and young, they can only build in safety on inaccessible crags. Ospreys were, however, sought in vain, these birds being persecuted by the Finns on account of the fish they destroy. An immense eagle's nest in one of the few trees remaining on the Murman coast was one of the "finds" of this trip. Very notable, also, was the discovery of a nest of the rough-legged buzzard on the ground. Among the prizes in the way of eggs may be mentioned those of the little stint and the dotterel, while those of the turnstone, although by no means uncommon, were exceedingly difficult to discover. A breeding colony of glaucous gulls yielded quite a harvest of eggs. Apparently the earliest breeder is the Siberian jay, which nests in April, when the country is inaccessible, except on ski. During his trip the author was fortunate enough to come across an old Finn who collected with John Wolley forty years ago on the Gulf of Bothnia.

The accompanying picture is an example of the illustrations which render this interesting and well written volume so attractive. R. L.

PROF. CHARLES SORET.

CHARLES SORET, honorary professor of physics at the University of Geneva, whose recent death we regret to announce, was born at Geneva on September 23, 1854. After a general course of study at the college and at the university of his native town, he devoted himself especially to the study of physics. In this he followed a family tradition, his father being the Genevese physicist Jacques-Louis Soret. Like his father, from whom he inherited his deep love and respect for scientific truth and his scrupulously exact method of working, he will be remembered as one of the most distinguished representatives of the science of Geneva. During many years, until the death of Louis Soret in 1890, he was his father's colleague and collaborator.

Charles Soret took successively at Paris the degrees of licentiate in physical science in 1876 and of licentiate in mathematical science in 1878. After a visit to Germany he returned in 1879 to the University of Geneva to fill the chair of mineralogy, a subject which, by the enthusiasm of his teaching, he rendered widely popular. His earliest works date from this period; they are published in the *Archives des Sciences physiques et naturelles* of Geneva, a journal with which he was associated during more than twenty years, and to the publication committee of which he rendered many signal services. Little noticed at first, the works of Soret opened out the way for other investigators; at the present day every mineralogist is acquainted with "Soret's Law" and "Soret's refractometer." Crystallography was the science especially cultivated by Soret; the subject-matter of his course was published by him in 1893, under the title of "Éléments de Cristallographie physique," a work well known and appreciated by specialists.

On Wartmann's death in 1886, Soret was called to the chair of experimental physics in the University of Geneva, and during two years he was burdened with a double duty. By transferring the mineralogy course to one of his students, he was enabled to continue his own peculiar studies, especially in the domain of crystallographic optics, for which he showed a marked preference. He was an excellent professor of physics and gave a new impulse to the study of that science at Geneva; the laboratory was largely extended, and many serious students came to group themselves around a master so conscientious as to devote himself almost exclusively to their scientific training. Soret would certainly have published more had he not given himself with so single a mind to the exacting and fatiguing duties of directing his laboratory.

A valued member of the faculty of science, he was at the same time appreciated by the whole university. After serving during a long period as secretary of the university senate, he was, in 1898, appointed to the honourable but exacting office of rector of the university. Owing to his serious qualities, to his firm but conciliatory character, he wielded great authority, and his duties as rector were filled with rare distinction. Applying scientific method in all things, he was a remarkable administrator, and many are the services he rendered to the university. But he overtaxed his powers, and when his rectorate expired, in 1900, he was forced to resign his professorship, a step which caused profound regret among his colleagues and friends.

After a rest of two years his health seemed re-established. He resumed his scientific activity and his researches in the laboratory that he had created. He had just published in the *Archives* for March, 1904,[1] a new investigation of the refraction of tourmaline when, on April 4, he was removed from his family and friends by a sudden illness.

The death of Soret is a great loss to his country and to science in general. Much might still have been anticipated from a mind so lucid, so methodical,

[1] The completion of this work is published in the May number of the *Archives*.

and so truly scientific. In spite of his modesty, his great natural abilities made him famous in Geneva, in Switzerland, and abroad. His death leaves a gap difficult to fill. R. Gautier.

PROF. THEODOR BREDICHIN.

For the past ten years Prof. Bredichin lived in well-earned and dignified retirement in Saint Petersburg. After a life spent in directing, with consummate ability, the activities of the two great astronomical observatories of Moscow and Pulkova, he sought, while his energies were still vigorous, opportunity for cultivating with greater leisure those studies to which he had conspicuously devoted himself while in a public position. In the midst of that self-imposed work and at the zenith of his reputation, he has been removed by death to the profound loss of science in Russia. In 1857, he was called to fill the chair of astronomy in the University of Moscow, and with it to undertake the direction of the observatory. There he remained for thirty-three years, and devoted himself to astrospectroscopic observation, a subject new in Russia, to the study of variable stars, to gravity determinations by means of pendulum observations, and to a host of inquiries with which his name has long been connected. But most of all was his attention concentrated upon the formation and behaviour of comet tails, a subject which had practically lain dormant since Bessel's researches on the comet of Halley. Of this subject he never wearied, and shortly before his death he collected and published his more important papers bearing on this inquiry. This revision was perhaps the more necessary since photographs had revealed minuter details than could easily be detected in the ordinary telescope. It must be a matter of gratification to his numerous friends that the distinguished astronomer, in spite of bad health, was able to complete a task which had occupied him for so many years.

In 1890, when Prof. Otto Struve retired from the direction of the Pulkova Observatory, Dr. Bredichin took charge of that institution, but his health did not permit him to remain long at this post, and in 1894, accompanied by the regrets of the staff, he resigned his position at the observatory, but not before he had given a decided impetus to the progress of celestial photography. We have already intimated how, in the remaining years of his life, he sought to promote the interests of his favourite science.

Some 150 papers on a variety of subjects were published by Dr. Bredichin, and by the foundation of prizes for special astronomical inquiries he still further encouraged the science. As a teacher he enjoyed the reputation of being able to inspire his pupils with a lifelong interest in astronomy, and the present position of the science in Russia owes not a little to the enthusiasm which he imparted to his pupils. At the age of 73, but with his faculties acute and with his interest in astronomy unimpaired, Russia has to regret the loss of one of her most brilliant sons, while science is deprived of an ardent and enthusiastic supporter.

ROYAL COLLEGE OF SCIENCE, 1903.

Science scholars selected from the whole of Great Britain for their ability and promise, maintaining themselves on 17s. 9d. a week, were this year saved from much privation by secret gifts of small bursaries—see the subjoined audited account. Prof. Perry says he has no right to ask for help from the generous men who helped him last year, but he has all the sturdiness of a chartered beggar—he asks in a good cause.

Royal College of Science.

BALANCE SHEET.

BURSARIES 1903–1904.

Moneys Received and Paid by Prof. Perry, November, 1903, and June, 1904.

Received		Paid	
Balance in hand from last year	£31 5 0	*Nov.* 16 *to April* 25. 27 students received half-bursaries ...	£135 0 0
September, 1903.		*March* 23.	
R. K. Gray, Esq....	10 0 0	1 student received the second half ...	5 0 0
B. Hopkinson, Esq.	10 0 0	*June* 10 *to June* 14.	
Sir A. Noble, K.C.B.	10 0 0	23 students received the second halves of their bursaries...	115 0 0
October 8, 1903.		Balance in hand ..	24 2 0
W. F. Stanley, Esq.	10 0 0		
The Drapers' Co....	100 0 0		
The Goldsmiths' Co.	100 0 0		
(*Royalties.*)			
Prof. Perry	5 7 0		
Paid back ,.. ...	2 10 0		
	£279 2 0		£279 2 0

Twenty-seven students received 5*l.* each; only twenty-four of them applied for the second halves of their bursaries.

Audited and Signed by John W. Judd.

Dated June 23, 1904.

NOTES.

An important deputation organised by the British Association will be received by Mr. Balfour to-morrow (Friday) afternoon, and will support the plea for the State endowment of higher education and research presented by Sir Norman Lockyer in his presidential address last year. Oxford and Cambridge will be represented by their Vice-Chancellors and others, London University by Lord Rosebery (Chancellor) and others, and the Birmingham University representatives will be headed by Mr. Chamberlain (Chancellor), who it is hoped will speak for all the new universities. According to a statement prepared by the president of the British Association and revised by a committee consisting of the Deputy Vice-Chancellor of Oxford, the Vice-Chancellor of Cambridge, Sir Oliver Lodge, principal of Birmingham University, Sir Michael Foster, M.P., and Sir Henry Roscoe, the British Association has taken action regarding the State endowment of universities, because at the present juncture the highest education and research is a matter not merely of academic, but of the gravest national concern.

Prof. G. Gaffky, professor of hygiene in the University of Giessen, has accepted Prof. Koch's vacant chair in the University of Berlin.

The following appointments are announced in connection with the Institut Marey:—Prof. A. Chauveau has been elected president and director; Prof. H. Kronecker becomes vice-President; Prof. M. Levy, treasurer; and Prof. G. Weiss, secretary.

The sixth centenary of the birth of Francesco Petrarca will be celebrated at Arezzo from July 20 to 25. Among the festivities will be an historic *fête* in the amphitheatre of the Prato in fourteenth century costume, commemorating the arrival of Petrarca at Arezzo in 1350.

The Mackinnon studentships of the Royal Society have been filled for the ensuing year by the election of Mr. Bryan Cookson for research in astronomy, and particularly for a new determination of the constant of aberration and

for an investigation of the mass and compression of Jupiter and of corrections to the elements of the orbits of his satellites; and to Mr. L. Doncaster for research on the early development of the egg, &c., in various species of sawflies, and for breeding experiments with certain species of Lepidoptera and with domestic animals.

A COMMITTEE has been formed in the Victoria University of Manchester to procure a portrait of Prof. Osborne Reynolds, F.R.S., the senior member of the teaching staff, as a memorial of the long and distinguished services which he has rendered to the Owens College and of his many valuable original contributions to physical science and engineering. In view of the eminent and widely recognised position which Prof. Reynolds holds as a scientific investigator, it is felt that there are many friends not immediately connected with the university who would be glad to be associated with the memorial. Any subscriptions should be sent to the treasurer of the Manchester Committee (Mr. S. Chaffers, Owens College).

SIR OLIVER LODGE, and other representatives of leading educational institutions in Birmingham, have addressed a memorial to the Lord Mayor of the city suggesting the establishment of a natural history museum on a portion of land recently acquired by the corporation. The memorial states:—"The absence of such a museum is, in our opinion, a grave defect in our municipal institutions, and is a matter of astonishment to strangers visiting our city. Several valuable collections of objects of natural history have already been lost to the city for want of a suitable building in which to deposit them, and many more collections—zoological, entomological, botanical, and geological—will find their way to metropolitan and other museums if suitable provision is not made in Birmingham for their reception."

IT is proposed to hold an optical convention in London next year. At a meeting held on Monday, in the rooms of the Society of Arts, Dr. R. T. Glazebrook, F.R.S., the president of the Optical Society, occupying the chair, an executive committee was elected, and the following were elected honorary vice-presidents:—Lord Crawford, Lord Rosse, Lord Rayleigh, Lord Blythswood, Sir William Abney, the Hon. Alban Gibbs, Mr. W. H. M. Christie (the Astronomer Royal), Mr. T. R. Dallmeyer, Mr. J. Stuart, Sir Howard Grubb, Dr. Glazebrook, and Lord Kelvin. One of the honorary vice-presidents will be asked to take the position of president of the convention.

THE report of the committee on ancient earthworks and fortified enclosures was presented to the congress of archæological societies on July 6. The committee expresses regret that more archæological societies have not taken up the idea of compiling a schedule of the ancient defensive works in their respective districts; and it is urged upon the secretaries of societies to arrange, when possible, for the survey and scheduling of all such works as are included in the inquiry. The committee concludes the report by again impressing upon archæologists the importance of doing their utmost to prevent the destruction which from time to time threatens so many defensive enclosures of earth or stone.

THE seventy-second annual meeting of the British Medical Association will be held at Oxford from July 26–29. The president is Dr. T. D. Griffiths, and the president-elect Dr. W. Collier. An address in medicine will be delivered by Sir William S. Church, Bart., K.C.B., and an address in surgery will be delivered by Sir William Macewen. A popular lecture will be delivered by Dr. G. Bagot Ferguson on Thursday evening, July 28. The annual meeting this year will comprise fourteen sections, which, with their presidents, are as follows:—Medicine, Dr. W. T. Brooks; Surgery, Mr. H. P. Symonds; Obstetrics and Gynæcology, Dr. F. H. Champneys; State Medicine, Dr. J. S. Haldane, F.R.S.; Psychological Medicine, Dr. C. A. Mercier; Pathology, Dr. J. Ritchie; Physiology, Prof. Francis Gotch, F.R.S.; Anatomy, Prof. Arthur Thomson; Ophthalmology, Mr. R. W. Doyne; Dermatology, Dr. T. C. Fox; Laryngology and Otology, Mr. C. J. Symonds; Tropical Diseases, Dr. A. Crombie, C.B.; Navy, Army, and Ambulance, Surgeon-General A. Frederick Bradshaw, C.B.; Dental Surgery, Mr. E. A. Bevers.

THE third annual meeting of the general committee of the Cancer Research Fund was held last Friday, July 8, at Marlborough House, the Prince of Wales occupying the chair. The report of the superintendent (Dr. Bashford) details the work that has been carried out during the past year. Specimens of new growths have been examined from a variety of animals, including fish and a wild mouse, showing that cancer occurs in animals in a wild state. Certain cells of malignant new growths have been found to present nuclear changes similar to those by which the sexual cells are prepared for fertilisation, and the fusion of nuclei has been demonstrated in tumours of the mouse. These observations suggest that the new growth of cancer is a mass of cells that has taken on an independent existence. Statistical investigations have also been carried out, and among other things do not support the widely spread belief that cancer is on the increase. The report of the treasurer appeals strongly for more extended pecuniary support; out of a population of 40 millions only 328 individuals and 10 city guilds have contributed, and the income has proved insufficient to meet current expenses.

ON Monday a large deputation waited on Lord Londonderry, President of the Board of Education, to urge the compulsory teaching of hygiene in elementary and secondary schools. The deputation was in support of a petition which has been signed by nearly fifteen thousand medical practitioners. The petitioners urged the central educational authorities of the United Kingdom to consider "whether it would not be possible to include in the curricula of the public elementary schools, and to encourage in the secondary schools, such teaching as may, without developing any tendency to dwell on what is unwholesome, lead all the children to appreciate at their true value healthful bodily conditions as regards cleanliness, pure air, food, drink, &c." The petitioners remark that a widespread ignorance prevails concerning not only the nature and properties of alcohol, but also its effects on the body and the mind. Central education authorities are therefore asked to include in the simple hygienic teaching desired elementary instruction at an early age on the nature and effects of alcohol. Dr. Farquharson, M.P., introduced the deputation, and short speeches in support of its objects were made by Sir W. Broadbent, Dr. D. Griffiths, Sir T. Barlow, Sir Lauder Brunton, Sir Victor Horsley, Dr. Mary Scharlieb, Dr. Hutchinson, and Prof. Sims Woodhead. Lord Londonderry, in reply, said the proposals made by the deputation had his sincerest sympathy, and he only wished it was in the power of the Board of Education to carry them out. He was as anxious as anyone to see increased instruction being given in the laws of health, but at the present time the necessary teachers did not exist, and he should be the last to wish anybody to act as instructor in such important subjects who had not received instruction in them. The Board was at the present moment

devoting itself to the training of teachers and instructing them properly in the whole question of hygiene. He trusted that as time went on its efforts in that direction would bring about the desired results.

In forwarding to Sir C. Eliot the meteorological returns from fourteen stations in British East Africa, for 1903, Dr. Johnson gives some particulars about the rainfall, and these have been forwarded to us by the secretary of the Meteorological Office. The average amount of rain did not fall in the coast region during the period covered by the report, only 33.84 inches being recorded at Mombasa, 23.24 inches at Malindi, 35.18 inches at Rabai, and Takaungu received 33.72 inches. Shimoni fared better in this respect, as 42.51 inches fell at that station. At up country districts the amount of rain was well up to the average; 80 inches fell at Mumias, 60 at Kisumu, and 51 at Fort Hall. The number of rainy days, *i.e.* days on which at least 0.01 inch of rain fell, varied from 23 at Kismayu to 174 at Eldoma; and at Machakos the number was 93; at Fort Hall, 110; at Nairobi, 111; at Kisumu, 127; and at Mumiàs, 145. The greatest amount of rain which fell in one day was 5.61 inches at Machakos, on April 28, and the next heaviest rainfall was 4.77 inches at Nairobi, on April 27. The Egyptian Survey Department having asked for returns relating to the lake levels, and also for returns of rainfall from places where the amount of water in the lake would be affected by the amount of rainfall, Dr. Johnson has forwarded instruments to the stations in question, viz.:—Nandi, Kericho, and Karungu. A supply of instruments has also been sent to Morendat and to Nairobi, and it is hoped shortly to supplement those already at Fort Hall.

In *Symons's Meteorological Magazine* for June there is a description of a new pattern rain gauge by Messrs. Lander and Smith, of Canterbury, a firm of chemists which has also recently produced some ingenious self-recording instruments. The chief novelty is that the glass receiver is permanently fixed to the funnel, and by means of a tube the contents can be emptied for measurement into an ordinary measuring glass. The latter is conical below, so that the graduation of small quantities of rainfall may be more accurately measured than is the case in an ordinary glass. A somewhat similar arrangement was proposed by Mr. John Aitken, F.R.S., in the same magazine in 1902, and Dr. Mill then pointed out that in Prof. Hellmann's rain gauges, used at official stations in Germany, the measuring glasses are constructed on the principle suggested by Mr. Aitken, the graduation of the first 10mm. being fifteen times as long as the others. The "Camden" rain glass recently designed by Messrs. Negretti and Zambra is also conical at the lower end. This arrangement enables the observer to decide, without guessing, whether in cases of very slight rainfall the amount is nearer 0.01 inch than 0.00, and consequently whether the day should be counted as a "rain-day" or whether the precipitation should be disregarded.

A new self-recording mercurial barometer has been devised by Mr. W. H. Dines, and is a much improved form of the instrument known as Milne's barograph. Its basis is, therefore, a glass syphon mercurial barometer, having its shorter limb, and a length of the upper portion of its longer limb, of considerably wider calibre than the remainder of the tube. In the shorter limb of the Dines pattern of the instrument, an iron float, of peculiar construction, moves freely, and through the medium of flexible lines connected to the arched heads of a lever-beam (or differential pulley) multiplication arrangement, this float actuates the recording pen. The clock movement is of Richard's type, and is enclosed within a long but light ebonite cylinder, which it drives, and on the outside of which is wrapped the chart (all the divisions on which are rectangular). The principal feature of Mr. Dines's new pattern of the instrument is a neat temperature-compensating arrangement embraced in the float. The iron float is essentially a cylinder, sealed and weighted at the top, but open underneath, below the level of the mercury in the short limb of the syphon, and when in position the cylinder contains air. It will be evident upon consideration that, given a suitable amount of air within such a float, the effect of the expansion (say) of that air on the occurrence of an increase of temperature will compensate for the alteration in the level of the mercury in the short limb of the syphon resulting from the expansion of the mercury in a syphon barometer having relatively wide upper and lower ends. Mr. Joseph Baxendell informs us that the latest pattern of the new instrument now in use at the Fernley Observatory, Southport, has been rendered practically frictionless, and that the Dines float modifications include a means of overcoming the errors commonly arising from the varying capillary effects occasioned by the reversal of the direction of motion of the mercury in the syphon.

Prof. George A. Gibson, writing in the *Proceedings* of the Edinburgh Mathematical Society, vol. xxii., directs attention to a weak point in the conventional treatment of tangents to circles and curves by the method of limits. In proving the tangent to be perpendicular to the radius, it is shown that when a straight line meets a circle in two points A, B, the line makes equal angles with the radii OA and OB, and since this is the case however near B is to A, it is said, "therefore the same result is true when B coincides with A." But, as Prof. Gibson points out, it would be equally logical to say that if OA is the perpendicular from O on a straight line, E any point on that line, $OE > OA$, however near E may be to A, and "therefore" the same is true when E coincides with A, which is of course absurd. The author remarks, "It is rather disheartening to find the absurdities, so clearly pointed out by Berkeley nearly two hundred years ago, still flourishing and apparently endowed with a new lease of life."

We have received the new volume of Dr. Otto Baschins's "Bibliotheca Geographica," covering the literature of geography to the end of 1900. The new issue does not contain any important new features, but it completes the first decade of a work recognised for its accuracy and exhaustiveness.

The Société d'Encouragement pour l'Industrie nationale has published a valuable paper on the Port of Rosario as a supplement to its May *Bulletin*. The author is M. Georges Hersent, and the paper deals fully with the past, present, and future of the seaport. Useful information about the economic geography of the Argentine generally is also to be found in an introductory chapter.

Among the most important recent additions to the cartography of Canada are a map of south-eastern Alaska and part of British Columbia, showing the award of the Alaska Boundary Tribunal, and a map of the North-West Territories and the province of Manitoba. The former is reduced from the original Canadian Boundary Commission map to a scale of 1 : 960,000, and contours at 1000-feet intervals are retained. The map of Manitoba is on a scale of $12\frac{1}{2}$ miles to an inch.

THE June number of the *National Geographic Magazine* contains a speculative article of considerable interest by Mr. R. A. Harris, in which the author discusses the indications of the existence of land in the vicinity of the North Pole, which are afforded by the known set of the currents in the Arctic Ocean and from observations of the tides. It is argued that a tract of land may exist extending from near the north-west corner of Banks Land, or from Prince Patrick Island, to a point north of New Siberia.

THE first place in the June number of *Petermann's Mitteilungen* is given to a short article on the geography of Tibet by Dr. E. Schlagintweit, accompanying an excellent map of central southern Tibet by Herr C. Schmidt. The map, which is on a scale of 1 : 2,000,000, is compiled from the most recent authoritative data, and the route of the British expedition to Gyangtse is shown. Another valuable paper on Tibet is Herr Richard Tronnier's study of the lives and journeyings of the Jesuit Fathers Johannes Grueber and Albert de Dorville, who crossed Tibet in 1661. This appears in the *Zeitschrift* of the Berlin Gesellschaft für Erdkunde.

DR. W. KOERT, of the Prussian Geological Survey, publishes in the *Naturwissenschaftliche Wochenschrift* for May an illustrated article on his observations of marine deposits and coast-erosion in many portions of the world. Among other interesting results of mineral and organic associations, he notes the formation of structureless calcareous concretions in the modern sand of Dar-es-salam, on the coast of German East Africa. These masses he compares with the "kankar" of Indian geologists.

THE fourth number of the *Boletin del Cuerpo de Ingenieros de Minas del Peru* contains an admirably illustrated account of artesian wells established at Callao. A venture started in 1901 was on the eve of being abandoned, when a copious supply of water was struck at a depth of 46 metres. Other wells have since proved equally successful, and Señor Guillet, the author of this memoir, sounds a note of hope for other areas, when he points out that there were no special geological indications to encourage hydraulic enterprise in the subsoils around Lima.

ACCORDING to the report in a local paper of a meeting recently held at Johannesburg, when Mr. W. L. Sclater, of the Cape Town Museum, occupied the chair, a South African Ornithological Union has been established. The new body has a strong and representative committee, with Mr. Sclater as president, and it is hoped that means will be found for publishing a journal.

WE have received from the United States two pamphlets connected with entomology, the one on some results of the work of the entomological division of the Department of Agriculture (*Bulletin* No. 44), and the other notes by Dr. A. S. Packard on the life-history of the silk-producing moths of the family Saturniidæ, forming No. 22 of vol. xxxix. of the *Proceedings* of the American Academy. Several articles in the former are devoted respectively to aphides affecting grain and grass, and to chestnut and other nut-feeding weevils.

PROF. HUBRECHT, of Utrecht, has favoured us with a copy of an article by himself from the *Jenaischen Zeitschrift* for 1904, dealing with the origin of annelids and chordates, and the systematic position of the ctenophora and platyhelminthes. Numerous debatable points—especially some connected with the "cœlosome"—are discussed in considerable detail, but it must suffice to mention that the author regards ctenophora and platyhelminthes as specialised side-groups, and that in his opinion the fœtal envelopes of mammals are directly derived from invertebrate ancestors, and not from those of birds and reptiles.

IN the *American Naturalist* for April, Dr. Shufeldt compares the various schemes of classification of birds which have been proposed during the last quarter of a century or so, and inquires why these are so different. The answer to the latter question is to be found, he thinks, partly in the homogeneous character of birds in general, and partly in the attempts to classify them in the same manner as other and less homogeneous groups. In this respect all classifications are more or less unsatisfactory, and it is no justification to plead that an "order" of birds has not the same systematic value as a division bearing the same name in mammals. Naturalists must make up their minds what characters are of generic and what of higher value, and then formulate a scheme which can be correlated with the classification of other groups. In another article in the same journal Mr. H. B. Bigelow records the results of certain experiments on goldfish which, in his opinion, prove that these fishes are endowed with the power of hearing.

WE have received Messrs. Merck's annual report on advancements in pharmaceutical chemistry and therapeutics. All the newer preparations and drugs receive notice, and the work contains useful bibliographical and authors' indexes and indications for treatment. No medical man or pharmacist who desires to learn the latest additions to the list of drugs can do without this report.

THE action of snake venom on cold-blooded animals has been tested by Dr. Noguchi in a long series of experiments (Carnegie Institution of Washington, *Publication* No. 12). Three venoms were employed, viz. those of the cobra, water moccasin, and rattlesnake. Snakes and frogs succumb easily to cobra venom, but are relatively insusceptible to the other venoms; turtles are more susceptible to all venoms than the foregoing, and fish are still more so. The grasshopper and some crabs are almost insusceptible, while the lobster is only moderately resistant. Excepting the earthworm, all the worms showed a low degree of susceptibility. The venoms have little effect on the Echinodermata; sea-urchins succumbed, however, but starfish and sea-cucumbers were not perceptibly affected.

"SILAJIT," an ancient Eastern medicine, forms the subject of a paper by Mr. David Hooper (*Journ.* Asiatic Society of Bengal, vol. lxxii., part ii., No. 3, 1903). There seem to be three substances known under this name; one appears as an exudation on the rocks in certain districts of the Himalayas, and consists largely of aluminium sulphate; a second, the black and probably true silajit, is said to form an exudation on rocks in Nepal, and consists mainly of alkalies and alkaline earths in combination with an organic acid related to humic acid; and a third, or white silajit, is apparently of animal origin. The substance is said to be a cure for most disorders. Mr. Hooper desires to direct the attention of other observers to this strange product, as it is possible that it has been met with in other parts of the world.

WE have received the "Year Book" of Livingstone College, of which Dr. Harford is the principal. This useful institution is designed to give to missionaries and others whose life-work may lie in the tropics a training in the elements of medicine, surgery, and hygiene such as may

be useful in districts remote from medical aid. Courses of elementary lectures are also given, both at the college and at the United Service Institution, open to all who may expect to reside or travel in the tropics. The "Year Book" contains details of the college and its curriculum, and useful directions for the preservation of health in the tropics.

In the short notice of Mr. Cecil Hawkins's "Elementary Geometry" in Nature of June 30 (p. 193), reference was made to the absence of numerical answers in the copy supplied. Mr. Hawkins asks us to state that the book is also supplied with answers if desired.

Messrs. T. C. and E. C. Jack, of Edinburgh, have submitted for our inspection four of the plates of a stereoscopic atlas of anatomy, edited by Dr. David Waterston, to be published by them in the autumn. The application of the stereoscopic principle to anatomical illustrations seems, from these examples of it, likely to prove of real assistance to medical and biological students. The plan has already been adopted with success in the teaching of geography and the illustration of books of travel, and there is every likelihood that this further adaptation of the stereoscope to educational work will meet with general approval from lecturers on anatomy. Each stereograph is accompanied by a brief description written by the editor, and the illustration and description are mounted on one card so as to facilitate reference from one to the other. The series will comprise 250 separate stereographs, and these will be contained in cases. The work will be issued at intervals in sections of about fifty stereographs.

OUR ASTRONOMICAL COLUMN.

New Elements and Ephemeris for Comet 1904 *a*.—In No. 55 of the Lick Observatory *Bulletins*, Prof. A. O. Leuschner, of the Berkeley Astronomical Department, gives a set of elements and an ephemeris for comet 1904 *a*, calculated from observations made by Messrs. Aitken, Crawford, and Maddrill on April 17, 22, and 29 respectively.

No. 56 of the same publication contains a second set of elements and an ephemeris calculated by Messrs. Aitken and Maddrill from observations made at Lick on April 17, May 8, and May 24. The following are the elements given:—

$$T = 1904 \text{ March } 6 \cdot 9049 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega &= 53^\circ\ 27'\ 13''\cdot 8\\ \Omega &= 275^\circ\ 46'\ \ 5''\cdot 5\\ i &= 125^\circ\ \ 7'\ 33''\cdot 1\end{aligned}\right\}\text{Mean equinox of } 1904\cdot 0$$
$$\log q = 0\cdot 432475$$

The ephemeris (for 0h. (G.M.T.) shows that on July 14.5 the comet will occupy the following position in the constellation Canes Ven.:—True $\alpha = 12h.\ 24m.\ 28s.$ True $\delta = +50^\circ\ 37'\ 50''$, and afterwards will travel very slowly in a southerly direction. As the brightness of the comet is now only 0.37 of its original magnitude, only the larger telescopes will be of any use in observing this object.

The Solar Parallax as Determined from the Eros Photographs.—At the meeting of the Royal Astronomical Society on June 10, Mr. Hinks gave an interesting and instructive account of the Cambridge reduction of all the available photographs of Eros obtained during the period November 7–15, 1900. One of the chief features of the paper was a description of the various errors which appeared during the reduction and of the methods employed for their elimination.

The value obtained for the solar parallax in this preliminary result was $8''.7966 \pm 0''.0047$, and this agrees, within the errors of observation, with that previously obtained by Sir David Gill, whilst the probable error is as small as that obtained by him.

Experiments on the Visibility of Fine Lines.—*Bulletin* No. 10 of the Lowell Observatory contains the details and results of a further series of experiments, performed by Messrs. Slipher and Lampland, on the visibility of fine lines at various distances. The experiments were exactly similar to those previously carried out with a fine wire of 0.7 inch diameter, except that a fine blue line 0.7 inch in width, drawn on a white disc 8 feet in diameter, was observed at the same time as the wire. At a distance of 1450 feet, when the angular width of the disc was 19′ and that of the lines was $0''.86$, the wire was certainly seen, but a fictitious line was seen accompanying what was supposed to be the real one.

The general results of the experiments indicated that the wire was more *generally* visible than the line, although at distances less than 400 feet the latter was the more readily seen.

Variability of Minor Planets.—Observations of the magnitudes of the minor planets Iris, Ceres, and Pallas, made by Herr J. Holetschek at Vienna during the years 1899 and 1903, are published in No. 3955 of the *Astronomische Nachrichten*. These show that the magnitude of Iris decreased from 7.4 to 7.6 between November 1 and November 6, 1899. Observing Ceres in April, 1899, it was found that the magnitude on April 9d. 14.5h. was 7.5, on April 13d. 11h. 8.1, and on April 14d. 15h. 6.9.

In the case of Pallas the following magnitudes were observed on the various dates named:—

1903	M.T. (Vienna)	Magnitude
March 23	7 6	8 4
24	7·6	8·7
24	9·8	8·6–8·7
25	7·7	8 4–8·5
26	7·6	8·5

A Variable Star Chart.—In No. 3959 of the *Astronomische Nachrichten*, Prof. Max Wolf publishes 25 charts, each showing the relative position of one of the 25 variables in Aquila mentioned in earlier communications published by him in the same journal. An accompanying table gives the chart number and the number, the position, the variation, and the designation of the comparison star for each variable.

The Leeds Astronomical Society.—No. 11 of the annual *Journal and Transactions* of the Leeds Astronomical Society contains reprints of seven very interesting lectures, on a variety of astronomical subjects, delivered at the society's meetings during last year. A number of letters on current astronomical questions, contributed to various periodicals by the past president, Mr. C. T. Whitmell, are also reproduced. The frontispiece shows a number of photographic reproductions of ancient coins on which were depicted various astronomical symbols, and illustrates a lecture on that subject delivered by Mr. A. Dodgson. The programme of the meetings for 1904 promises some very interesting papers, whilst the report for 1903 shows the society to be in a thriving condition.

"Annuario" of the Rio de Janeiro Observatory (1904).—The twentieth annual publication of the Rio de Janeiro Observatory contains a large amount of useful information on astronomical, meteorological, and general physical matters. The customary calendars and astronomical tables are given in part i. Parts ii., iii., and iv. contain tables of reduction for astronomical and meteorological observations. The usual tables for the conversion of foreign standards are given in part v., whilst the sixth and last section contains many useful records of the local meteorological and magnetic conditions for past years, including the variation of magnetic declination at Rio de Janeiro since 1660.

GEOLOGICAL SURVEYS OF THE UNITED STATES.

Since the appearance of the notice in Nature of December 3, 1903, the following publications of the United States Geological Survey have been received.

1. *Bulletins.*

Of very wide interest is the essay on "The Correlation of Geological Faunas: a Contribution to Devonian Palæontology," by Prof. H. Shaler Williams (*Bulletin* No. 210). The observations are based on a critical examination of the

Devonian rocks of New York, Pennsylvania, and eastern Ohio, as in that region the stratigraphical succession and the continuity of the rocks were sufficiently clear to enable the author and his assistants to work out the relations between the geological formations and the distribution of life. The term fauna is commonly used in palæontology to indicate the list of fossils contained in a single formation, but as the author admits, the limits of formations vary considerably in different localities, and do not coincide with the limits of faunas. He introduces the term *faunule* to distinguish an aggregate of fossils associated either in a single stratum, or in several contiguous strata that may be many feet in thickness—the aggregate being composed of the same set of species. The *fauna*, on the other hand, is defined as an aggregate of local and temporary faunules in which is expressed a common, corporate aggregate of species. The faunule is limited to a single set of conditions. The fauna is to be discriminated by the dominant species, and it preserves its integrity and identity so long in succession, and so far in distribution, as the dominant species retain their ascendancy among their associates. The marine fauna itself is not the universally distributed marine life of a particular epoch, but the fauna of a particular environment of that epoch.

The facts recorded by the author show that migration, not of single species, but of the whole fauna has sometimes taken place. There has been transgression of one fauna over another, thus calling for the assumption that the limits of a formation based upon sudden change in the fossil contents cannot be regarded as synchronous for two parts of even the same province, and, wherever they are thus sudden and sharp, cannot be synchronous with the limits of either the earlier or later fauna in evidence. The detailed study of the migrations and recurrence of species is of the utmost importance, and in this respect alone we have much to learn. The author rightly remarks that for the practical purposes of geological mapping and the descriptions of geological structure the formations are the essential elements, while his statistics demonstrate the intrinsic value of fossils for measuring and indicating geological time. His observations show the necessity for a dual nomenclature—stratigraphical and biological—and they indicate also that "At present we know too little about fossil faunas to be able to predict in what manner their actual time limits will be defined or discriminated, but enough light has already been thrown upon the matter to show that it will be by means of the history which organisms have expressed in their continuous life and evolution that we may expect ultimately to mark off the stages of geological time."

"Notes on the Geology of South-western Idaho and South-eastern Oregon" are contributed by Mr. Israel C. Russell (*Bulletin* No. 217). The notes are the result of a rapid reconnaissance made with the special view of studying the artesian basins; these comprise large tracts of rich agricultural land, throughout which the conditions justify the opinion that flowing water may be obtained. Particular descriptions and illustrations are given of the cinder buttes and craters of the recent, but now extinct, volcanoes. At each of the volcanic centres it seems that the first eruptions were of the explosive type, and that the elevations then produced by the accumulation of projectiles were to a considerable extent buried by the subsequent quiet effusion of vast quantities of liquid lava (basalt).

"Descriptive Geology of Nevada South of the Fortieth Parallel and Adjacent Portions of California," by Mr. J. E. Spurr (*Bulletin* No. 208), contains particulars of a great variety of formations from Archæan to Carboniferous, also of Jura-Trias, Tertiary, and later deposits, as well as of granites, rhyolites, andesites, and other igneous rocks. The work is based on a series of traverses, and is to be regarded as a preliminary survey, as the topographic map is imperfect; but the records of facts observed are full of interest.

"The Geology of Ascutney Mountain, Vermont," is by Mr. R. A. Daly (*Bulletin* No. 209). In this work we have the results of an investigation of the lithology and geology of a plexus of eruptive rocks and of the metamorphic aureole in bordering schistose rocks. The author concludes with hypotheses on the manner of intrusion, on abyssal assimilation, and on the evidences of differentiation of the igneous masses.

"Stratigraphy and Palæontology of the Upper Carboniferous Rocks of the Kansas Section" is the title of a report by Messrs. G. I. Adams, G. H. Girty, and David White (*Bulletin* No. 211). This work summarises the information on the subject, including extensive faunal lists and such data as are available concerning the flora. The plants appear to represent the topmost Carboniferous, if not the so-called permo-Carboniferous, of western Europe.

Economic geology is dealt with in *Bulletins* Nos. 212, 213, 218, 219, 223, and 225. "The Oil Fields of the Texas-Louisiana Gulf Coastal Plain" are fully described by Messrs. C. W. Hayes and W. Kennedy; "The Coal Resources of the Yukon, Alaska," are discussed by Mr. A. J. Collier, who considers that with proper development there will probably be sufficient coal to supply local demands for some time to come; "The Ore Deposits of Tonopah, Nevada," are reported on briefly by Mr. J. E. Spurr, who points out that the most important mineral veins occur in the early Tertiary andesites, and that the values in the ores are entirely gold and silver; "Gypsum Deposits in the United States," by G. I. Adams and others, are treated with especial reference to economic conditions; and "Contributions to Economic Geology," 1902 and 1903, have been prepared by a number of authors under the direction of Messrs. S. F. Emmons and C. W. Hayes; these contributions relate to metalliferous deposits, coal, oil, gas, stone, cements, clays, fuller's earth, gypsum, phosphates, mineral paints, &c.

In *Bulletin* No. 220, Mr. F. W. Clarke has tabulated the "Mineral Analyses from the Laboratories of the U.S. Geological Survey, 1880 to 1903."

In *Bulletins* Nos. 214, 215, 216, 221, 222, 224, and 227, we have a catalogue and index of the publications of the United States Geological Survey, 1901 to 1903; bibliography and index of North American geology for 1902; catalogue and index of the publications of the Hayden, King, Powell, and Wheeler surveys; results of primary triangulation; geographic tables and formulas; gazetteer of Texas, edit. 2; and "The United States Geological Survey, its Origin, Development, Organisation, and Operations."

II. *Monographs.*

Monograph No. 44 contains the last work of Prof. Alpheus Hyatt, the "Pseudoceratites of the Cretaceous"; this was almost ready for the printer at the time of his death in January, 1902, and it has been edited by Mr. T. W. Stanton. It is illustrated by 47 plates, and these, together with the descriptions of species and the reference of these and other species to new genera of Ammonoidea, were arranged or selected by the author. As the editor remarks, "The multiplication of families, genera, and species will be understood by all who are acquainted with Professor Hyatt's habit of attempting to express in the terminology every important fact observed in the course of his investigations." In some cases the classification of the forms is incomplete, as the author's opinions on certain questions had evidently become much modified since his previous publications. The Pseudoceratites he speaks of as "an artificial group, including for convenience of treatment all the retrogressive genera of the Cretacic that have sutures with simple outlines resembling those of Triassic cephalopods, formerly included under the name Ceratites." Among the British forms referred to is *Ammonites* (*Mantelliceras*) *Mantelli*, of Sowerby.

Monograph No. 45 is on "The Vermilion Iron-bearing District of Minnesota," by Mr. J. Morgan Clements, and it is accompanied by a folio atlas of geological, mining, and topographic maps. This great iron-bearing district has an area of, approximately, 1000 square miles in north-eastern Minnesota, and it resembles the other iron-bearing districts of the Lake Superior region in that the rocks are of great geological antiquity. Iron ore was first noticed in the district in 1850, but its economic importance was not realised until long subsequently. The ores occur in four areas, one of which includes the Giant's Range, which attains a height of 2120 feet above sea-level. The rocks comprise Archæan, divided in ascending order into the Ely greenstone, the iron-bearing Soudan formation, and various granites. The greenstones, though highly altered, are largely of volcanic character, but with them are associated

some intrusive rocks which present in many cases a schistose character. The Soudan formation, the oldest sedimentary group in the district, is bent into prominent anticlines, but is otherwise intricately contorted and infolded with the greenstones; it comprises conglomerates with fragments of the older greenstones, and an outlying group of siliceous rocks, largely white cherts, with red jasper and carbonate-bearing chert, grünerite-magnetite-schist, blue hematite, magnetite, and small quantities of pyrite. The cherty rocks are banded, and the hematite occurs in certain places in masses of variable size, which constitute the ore deposits. These iron-bearing rocks are considered to be of sedimentary origin. The source of the iron was, in the first instance, the Ely greenstone. From this it was removed through the action of water and collected to form part of the sedimentary marine deposits of the Soudan formation. After the folding of the rocks this disseminated iron was carried by downward-percolating waters into places favourable for its accumulation. The methods of mining are described. There are descriptions also of the later intrusive rocks, of the Huronian and Keweenawan series, of the drifts, the Glacial lakes, and other topographic features.

Monograph No. 46, on "The Menominee Iron-bearing District of Michigan," by Mr. W. S. Bayley, is the sixth and last of a series of reports on the iron-bearing districts of the Lake Superior region. The area now described is a very important one, as it has yielded since 1877 nearly thirty millions of tons of iron-ore of Bessemer grade. The rocks comprise Archæan schists and granites, which appear on the borders of the district; in the central portions the iron-bearing Algonkian rocks, with basal conglomerate, occupy a trough of highly folded rocks, distinguished as the Lower and Upper Menominee series, there being a marked unconformity between them. These divisions correspond to the Lower and Upper Marquette series, and to the Lower and Upper Huronian of other areas. Above these folded rocks lie horizontal Palæozoic beds, comprising the Lake Superior sandstone and an Ordovician limestone. The Lower Menominee series comprises quartzite and dolomite, the latter affording a key to the folding. The gap between Lower and Upper Menominee series is marked by conglomerate at the base of the Upper series, which contains pebbles of jaspilite (iron-bearing), and these are taken to represent the Negaunee formation. The Upper Menominee series comprises also slates, quartzites, and jaspilites, these last-named being banded rocks composed of alternating layers of red jasper and ore-deposits. It is noted that the larger ore-deposits all rest upon relatively impervious foundations, which are in such positions as to constitute pitching troughs. The processes of concentration were the same as those worked out in other districts by Van Hise, being due to descending waters flowing in definite channels. The concentration was commenced after the folding of the rocks, and completed before the beginning of the Upper Cambrian. The subject is treated very fully from all points of view, structural and physiographic as well as economic, and it is profusely illustrated with maps, sections of the strata, microscopic sections of rocks, and pictorial views. There are also two plates of possible organic markings from the iron-bearing rocks of Chapin Mine; these were thought by Mr. W. S. Gresley to represent impressions of plants, track-marks, &c.

III. *Professional Papers.*

The United States Geological Survey has issued a series of "Professional Papers," of which we have received several examples. No. 11 is on "The Clays of the United States East of the Mississippi River," by Mr. Heinrich Ries. It is interesting to note that while kaolins occur in several States, the local output at present is insufficient to meet the demand. No. 12, by Mr. F. L. Ransome, deals with the "Geology of the Globe Copper District, Arizona." No. 13 is on "Drainage Modifications in South-eastern Ohio and Adjacent Parts of West Virginia and Kentucky," by Mr. W. G. Tight. The subject is one which attracts a considerable amount of interest, so far as it illustrates the history of rivers and the relation of the old to the present river systems. The author concludes that the high-level valleys of the region represent a connected system of an old drainage cycle which antedates the first advance of the ice of the Glacial period; that the deposition of the silts on the old valley floors and the deflection of the streams producing the present drainage system were due to the action of the advancing ice-sheet of the first Glacial epoch; that the extensive erosion of the present river valleys to depths below the present drainage lines was accomplished during an inter-Glacial interval of great duration; and that these inter-Glacial valleys were partially filled with débris by the flood waters of the last Glacial epoch, the post-Glacial erosion being represented by the channels cut in the floor of these deposits since the rivers have acquired their present volume. Paper No. 14, by Mr. Henry S. Washington, comprises a laborious but most useful work, entitled "Chemical Analyses of Igneous Rocks Published from 1884 to 1900, with a Critical Discussion of the Character and Use of Analyses." The analyses follow on from the last date of publication of Roth's "Tabellen," and include a few analyses of 1883 omitted from that work. The author insists on the importance of careful and precise work, lamenting that rock analyses are too often entrusted to inexperienced students. The work will be of the greatest value to petrologists. Paper No. 15 is on "The Mineral Resources of the Mount Wrangell District, Alaska," by Messrs. W. C. Mendenhall and F. R. Shrader. It deals with the occurrence of ores of copper, gold, silver, platinum, tin, mercury, osmiridium and iron, and also with a few indications of coal or lignite.

No. 16 is on "The Carboniferous Formations and Faunas of Colorado," by Mr. G. H. Girty. This work is based on the extensive collections of fossils of the Geological Survey and the National Museum, and its purpose is to ascertain, by means of the invertebrata, their grouping into local and formational faunas. It brings out the close relation which existed in Carboniferous time between the Colorado seas and those of the Mississippi valley. The Leadville, Millsap, and Ouray limestones which form the base of the Carboniferous, and which include a part of the Mississippian fauna, include also in their lower portion a distinctive Upper Devonian fauna. The Lower Carboniferous was followed by an epoch of elevation and erosion, and none but the early portion of the Mississipian time is represented in the Colorado sediments. This lower group comprises (1) the Weber formation, of dark carbonaceous shales and thin limestones, with fossils of Coal-measure type, and (2) the Maroon formation, a great series of conglomeratic beds and grits, surmounted by red sandstones. The same difficulties that have been met with in Britain are encountered in Colorado, and the author discusses at some length the question whether certain red beds are Carboniferous, Permian, or Triassic. The Wyoming "Red Beds series" appears to succeed the Maroon formation in places without a break, but the author regards it as really Triassic. The numerous descriptions of fossils are accompanied by ten plates.

No. 17, by Mr. N. H. Darton, is a "Preliminary Report on the Geology and Water Resources of Nebraska West of the 103rd Meridian." The geology and topographic features are described, and some remarkable monuments of erosion known as the Chimney rock, the Smokestack rock, and the Twin-sisters are represented on photographic plates. There is also a figure of the Titanotherium, which is found in the basal portion of the Tertiary strata.

In No. 18, Mr. J. P. Iddings contributes an essay on "Chemical Composition of Igneous Rocks Expressed by Means of Diagrams with Reference to Rock Classification on a Quantitative Chemico-mineralogical Basis." In introducing this work Mr. Whitman Cross remarks, "As a successful attempt at the elucidation of a complex problem the paper is of importance to all students of igneous rocks."

In No. 19, "Contributions to the Geology of Washington," by Mr. G. O. Smith and Mr. Bailey Willis, the authors deal chiefly with the origin of the physical features. No. 20, "A Reconnaissance in Northern Alaska," by Mr. F. C. Shrader, with notes by Mr. W. J. Peters, contains much interesting information about tracts hitherto unexplored. Among the rocks described are Silurian, Devonian, Carboniferous (?), Jura-Cretaceous, Cretaceous, and Tertiary, as well as Drift deposits. The mineral resources, climate, population, and other subjects are dealt with.

IV. *Reports.*

Part i. of the twenty-fourth annual report for 1902–3 contains an account of the progress of the Survey by Mr. C. D. Walcott, director, who refers to the increase of work, and to the establishment of a separate hydrographic department under the charge of Mr. F. H. Newell. An obituary memoir, accompanied by a portrait, is given of Major J. W. Powell.

The detailed report on the "Mineral Resources of the United States," for 1902, by Mr. David T. Day, shows a continuation of the remarkable activity in the mineral industries, the total value exceeding one thousand million dollars—iron and coal being the most important products. There was a notable increase in the production of uranium and vanadium minerals, and these were nearly all shipped abroad in the crude state as mined. The production of bauxite was largely increased, while that of monazite, obtained chiefly from North Carolina and partly from South Carolina, showed a slight increase over the previous year. The production of crude petroleum and of natural gas also showed increase.

V. *Local Surveys.*

The Wisconsin Geological and Natural History Survey has sent copies of *Bulletins* Nos. 11 and 12. The former is a "Preliminary Report on the Soils and Agricultural Conditions of the North-central Portion of the State," by Dr. S. Weidman. It is illustrated by a soil map, on the scale of an inch to three miles, and this gives the general character of the soil over different "soil formations" or subsoils—in reality various alluvial and drift deposits. No. 12 is by Mr. C. D. Marsh on "The Plankton of Lake Winnebago and Green Lake," lakes of different types, one shallow, the other deep. As bearing on the question of fish-production, it is noted that Entomostraca, which furnish the basis of food for fishes, are more numerous in the deep than in the shallow lake.

We have received also vol. xiii. of the *Memoirs* of the Iowa Geological Survey, being the annual report for 1902 with accompanying papers. The papers comprise descriptions (seven in number) of various counties, by the State Geologist, Mr. Samuel Calvin, and his assistants. There is also a discussion of the requisite qualities of lithographic limestone, with a report on tests of the lithographic stone of Mitchell County, Iowa, by Mr. A. B. Hoen. The report is accompanied by a colour-printed plate drawn on the local stone and illustrating the quarry from which it was obtained. The sample, submitted for trial, was not wholly satisfactory, inasmuch as it was noticed in trueing the stone for printing that the surface-plane intercepted planes of bedding at small angle, but there is reason to hope that, as the stone is worked, larger and more perfect slabs may be obtained. H. B. W.

DISINFECTING STATIONS.

An interesting article upon disinfecting stations, written by Prof. Henry R. Kenwood and Mr. P. J. Wilkinson, appears in the most recent issue of the *Journal* of the Sanitary Institute (vol. xxv., part i., April; London: Offices of the Sanitary Institute, Parkes' Museum, Margaret Street, W.).

It is now well recognised that the disinfection of textile articles can be effected by the use of steam more quickly, more certainly, and with less damage to the article disinfected than by the use of any other agent; and a steam disinfecting station is now considered an essential provision by sanitary authorities. As the steam penetrates into the interstices of the colder articles it undergoes condensation, and imparts its latent heat instantaneously to the colder objects in contact with it. Steam thus condensed into water occupies only a very small fraction (about 1/1600) of its former volume, and to fill the partial vacuum thus formed more steam presses forward, in its turn becoming condensed and yielding up its latent heat, and so on until the whole mass has been penetrated.

Saturated steam may be used as current steam at about atmospheric pressure; but there is an advantage, in point of time, in the employment of steam disinfecting apparatus in which saturated steam is used under pressure, and higher temperatures are thereby obtained, when very highly resistant organisms have to be destroyed.

The time required for disinfection by steam obviously depends upon the resistance of the organism to be destroyed, the bulk of the infected articles, and the pressure of the steam employed. The best researches indicate a pressure of 10 lb. (and therefore a temperature of 115° C.) for twenty minutes as trustworthy in general practice.

The steam may be generated in a special boiler, from whence it is conducted to the disinfecting chamber, and such a boiler is sometimes made to supply steam for laundry purposes; or the lower part of a jacketed oven may be filled with water, and by firing directly under the machine the steam may be raised in the jacket of the disinfector itself. This arrangement favours compactness and economy, but a separate boiler is more accessible for cleansing and repairs.

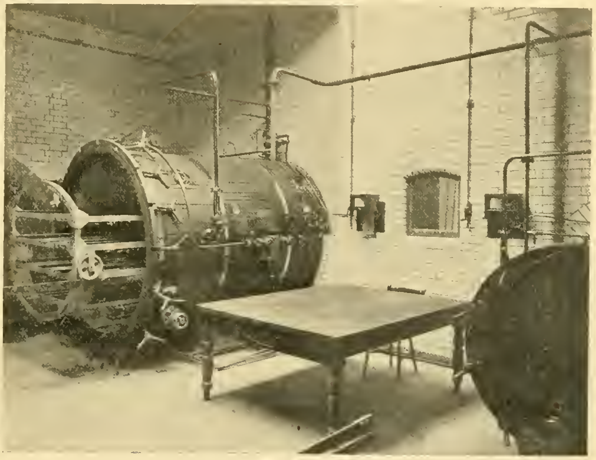


FIG. 1.—Interior of non-infected Chamber at the Fulham Disinfecting Station.

The various stoves now employed for disinfecting by steam may be classified as follows:—

(1) Stoves in which steam without pressure is employed. These are, of course, the simplest and cheapest.

(2) Those in which steam at low pressure (2, 3 or 5 lb. per sq. in.) is used. Although the temperature of 110° C. which can be reached by some of these stoves is generally sufficient, a higher temperature can never be employed in them. These stoves, though cheaper, meet with less general acceptance in this country than

(3) Those in which steam at high pressure (10 lb. and over) can be employed.

A temperature of 115° C. to 120° C. can be obtained in these stoves, and an exposure of articles for about twenty minutes will suffice for disinfection.

A disinfection station should comprise:—

(1) Two rooms completely separated from each other by

a wall, into which the oven is built, so that it communicates with both rooms. In one chamber the infected articles are placed in the oven, and when disinfection is complete the articles are taken out in the other chamber.

(2) An incinerator or destructor for the combustion of useless infected articles.

(3) Separate sheds for (*a*) vans employed to bring infected articles, and (*b*) vans employed to return disinfected articles.

(4) A laundry and bath-room.

The article describes the forms of stoves mostly used in this country at the present day, the planning and construction of the disinfecting station, the staff, the disinfection of articles (leather goods, furs, feathers and books) which are injured by steam, the destruction of useless articles in a destructor furnace; and much useful information as to cost is also given.

The article is well illustrated. The illustration here reproduced shows the non-infected chamber; the door of one of the ovens is open, and the wheeled carriage running on internal rails is seen with the racks on which the clothing and bedding are placed. The observation window in the partition wall is permanently closed.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The physiological laboratory of the University of London will remain open for post-graduate research students during the vacation months August and September. Foreign graduates who may be desirous of working in the laboratory should previously communicate with the director or with the academic registrar of the university.

A course in practical and clinical bacteriology will be held at King's College, University of London, from Wednesday, August 3, to Saturday, August 13. The course will consist of lectures, demonstrations, and practical work; in the latter, the members of the class will make for themselves permanent preparations of the chief pathogenic micro-organisms, and will carry out the principal manipulations employed in bacteriological investigations. Names should be sent in as soon as possible to the secretary or to Prof. Hewlett.

We directed attention a short time ago (June 9, p. 138) to the new illustrated quarterly review *Buddhism*; in the third number is an interesting article on education in Burma, in which it is stated that the vernacular lay schools introduced by the British Government are by no means an unqualified success, since they have been organised without due regard for native conditions. "What object," says the anonymous writer, "has education to a jungle Burman except to form his character? And can Burmese character be moulded by studying the history or geography of Europe or standard readers garbled under European supervision? A Burman should be taught Burman ethics, morals and usage. The disobedience to the authority of parents, which is so alarming a feature in the present state of things, requires to be specially dealt with. The evil goes beyond mere disobedience and truancy—cases where boys rob their parents or wantonly commit other breaches of the law are increasing." Evidently Burma also is suffering from that peculiar British attitude of mind that seeks to constrain all peoples to conform to the ideals and methods of the Britons themselves.

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 9.—"On the Action of the Venom of *Bungarus coeruleus* (the Common Krait)." By Major R. H. **Elliot,** I.M.S., W. C. **Sillar,** M.B., B.Sc., and George S. **Carmichael,** M.B., Ch.B.

Experiments were performed by the authors in the pharmacological laboratory of the University of Edinburgh with the following results:—

(1) The minimum-lethal dose of the dried venom was determined for frogs and small mammals, rats and rabbits. It was found that the M.L.D. for the frog was about 0·0005 of a gram per kilo., for the rat 0·001 gram per kilo., and for the rabbit the remarkably low dose of 0·00008 gram per kilo.

(2) It was found that Calmette's anti-venomous serum in quantities sufficient to protect rats against ten minimum lethal doses of cobra venom, in the same quantities was quite powerless to protect these animals from similar doses of krait venom.

(3) The condition of various nerve terminals was studied, both in animals that die after poisoning by krait venom and in nerve muscle preparations from the frog, and it was found that the integrity of these nerve ends was invariably involved at a comparatively early stage in the poison.

(4) The blood was carefully examined, and no evidence of antemortem clotting or intravascular hæmolysis was discovered.

(5) The action of krait venom was examined when its solution was perfused through the isolated vessels and heart, respectively, of the frog. It was found that this venom, while resembling in action that of cobra venom, differs greatly in the degree of constriction of vessels and enhancement of ventricular contraction produced. Cobra venom exercises an action in these directions many times greater than that of krait venom. Cardio-plethysmographic tracings are shown.

(6) Studying the manner in which the vital functions of mammals (rabbits, cats, and dogs) are influenced when exposed to the action of this venom, the authors show by means of kymographic and plethysmographic tracings that the vaso-motor centre is strongly affected, a suspension of the activity of this centre, as shown by the great splanchnic dilatation, rapidly ensuing after its transient stimulation. There are also indications of a feeble cardio-inhibitory action. The experiments and illustrative tracings likewise show that death is brought about by destroying the activity of the respiratory centre.

(7) From these results the conclusion may be arrived at that while the symptoms produced by krait poisoning are similar to those of cobra poisoning, they differ so much in relative degree as to render it doubtful if they can properly be spoken of as identical.

"Contributions to the Study of the Action of Sea-snake Venoms. Part i." By Sir Thomas R. **Fraser,** M.D., F.R.S., and Major R. H. **Elliot,** I.M.S.

The venoms used in the research were those of *Enhydrina Valakadien* and *Enhydris Curtus*.

The minimum-lethal doses of *Enhydrina Valakadien* venom were found to be:—for rats = 0·00009 gram per kilo. of body weight, for rabbits = 0·00006 gram per kilo. of body weight, for cats = 0·0002 gram per kilo. of body weight.

The minuteness of these doses indicates that sea-snake venom is the most lethal of all substances the lethal power of which has been determined.

Symptoms of Sea-snake Poisoning in Animals.—In the main these symptoms resemble those of cobraism, but the dyspnœa is more urgent.

Summary of Results.

(1) Enhydrina venom has no direct action on the walls of the arterioles, or at least has no action in any strength of solution which could be present in the blood of a human victim of sea-snake bite.

(2) Enhydrina venom acts directly on the isolated frog ventricle, producing a tonic and stimulating effect, but this action is produced only by very strong solutions (1 : 5000). The heart-beat is quickened, and the result is therefore similar to that produced by very weak solutions of cobra venom (1 : 1,000,000 or weaker).

(3) By experimenting with the mammalian heart exposed *in situ*, the authors have shown that Enhydrina venom has no direct action on the vagal cardio-inhibitory centre. This affords a striking contrast to the condition observed in cobra poisoning. In the latter case, the powerful tonic and stimulant action of the venom on the heart-muscle (or more probably on its nerve-ends) is masked by equally powerful and direct stimulation of the cardio-inhibitory centre. In Enhydrina poisoning, on the other hand, the complete absence of cardio-inhibition leaves the feeble tonic action on the heart free to manifest itself, as appears to be displayed in several of the tracings. The authors cannot

otherwise explain the increase in rate of the heart-beats which they not infrequently met with in their experiments.

(4) Enhydrina venom has apparently no direct action on the vaso-motor centre.

(5) The blood-pressure curve in Enhydrina poisoning is a remarkably steady one, provided that moderate doses of venom are given and that care is taken to avoid the injection of large volumes of fluid into the blood vessels. This is due to the fact that the blood pressure is exposed neither to the influence of the rival forces which act on the heart so strongly in cobraism, nor to the direct vaso-motor changes which characterise the action of certain other venoms.

(6) The respiratory mechanism is that which is chiefly affected by Enhydrina venom. If large lethal doses are employed respiration falls rapidly, and a considerable rise of blood pressure, asphyxial in origin, may precede death. The heart-beat then quickly slows, and blood pressure falls with corresponding rapidity.

Obviously, these are simply the phenomena of rapid asphyxiation. If, however, smaller lethal doses of venom are employed, no marked rise in blood pressure occurs. The ordinary level is maintained until near the occurrence of death; the beat then slows, and the blood pressure falls. Here we have an expression of gradual cardiac failure, brought about by slowly progressive asphyxiation. The absence in slow Enhydrina poisoning of the large asphyxial rises of pressure which are so characteristic of the final stages of cobra poisoning is readily explained by the fact that Enhydrina venom has no direct constrictive action on the walls of the arterioles, such as cobra venom possesses.

(7) As to the part of the respiratory mechanism that is affected by sea-snake venom, the rapidity with which respiration is affected, both when venom is injected into a vein and also when it is applied directly to the medulla oblongata, leaves no room to doubt that the respiratory centre is directly acted on by the venom. On the other hand, some degree of motor nerve-end paresis is constantly present in animals dying from the effects of subcutaneous injections of this venom. The fact is emphasised that, in experiments carried out by dropping venom on the exposed medulla oblongata, animals were not killed through the respiratory centre with their motor nerve-ends still undamaged. In this respect, Enhydrina venom differs in its action from cobra venom. It would therefore appear that, in poisoning with Enhydrina venom, motor nerve-end paresis plays a much greater part than it does in cobraism. It is not difficult to suppose that a blunting of the motor nerve-end mechanism, even though far from absolute, may seriously add to the embarrassment of a centre which has already been directly and gravely enfeebled.

"On the Structure and Affinities of Palæodiscus and Agelacrinus." By W. K. **Spencer,** B.A., F.G.S. Communicated by Prof. W. J. Sollas, F.R.S.

The method employed was that devised by Prof. Sollas (*Phil. Trans.*, B, vol. cxcvi.). This method introduces a new field of research to palæontologists, for an accurate model of the internal parts of fossils may be made by the investigator. Specimens of the above genera were ground by a special machine at uniform distances of 1/40th mm., and each successive surface photographed. From tracings of the photographs obtained wax models were built.

Palæodiscus and Agelacrinus were chosen for investigation because many observers have claimed them as possessing primitive and ancestral characters.

Palæodiscus is one of the oldest echinoids known, occuring in the Lower Ludlow beds of Leintwardine. It is shown to possess features which are only found in embryonic echinoids of the present day.

No interambulacral plates are present in the peristomial region. The interambulacrum possesses only a single initial plate proximally to the mouth. The vast majority of the plates of the interambulacrum are rhomboidal. The outer surfaces of the pyramids are concave. Other Palæozoic echinoderms may possess these characters, as shown by Jackson, but no other echinoid possesses so many undoubtedly primitive characters. This makes the important discovery of Prof. Sollas (confirmed by the author), that there are two series of plates in the ambulacrum, much easier to understand. The outer series was compared to the true echinoid ambulacrals, the inner series to the asteroid ambulacrals. Palæodiscus would then be placed at the base of the echinoid stem, and would enable us to derive the echinoids from asteroid ancestors. The asteroid series of plates of Palæodiscus is represented in other echinoids by the auricles which were shown by Lovén to have an independent origin and growth. It is noteworthy that this comparison was instituted by Johannes Müller so long ago as 1853.

Agelacrinus is a member of the recently revived group of the Edrioasteroidea. This group has been claimed as ancestral to free moving echinoderms by Neumayer, Haeckel, and Bather. The genus Edrioaster, on which most of the previous investigations have been conducted, lends support to this suggestion, for it possesses a double series of flooring plates to the ambulacral groove between which are pores. It was therefore suggested that since the Edrioasteroidea alone amongst Pelmatozoa possessed pores through which the eleutherozoan ampullæ could be protruded, they were the pelmatozoic ancestors of the free moving echinoderms.

Agelacrinus is shown, however, to possess single flooring plates, and no pores are present either through or between these plates. The pores of Edrioaster, therefore, are not so characteristic or important a feature of the Edrioasteroidea as the above authors would claim.

In conclusion, it is pointed out that the Asteroidea are the most primitive Eleutherozoa, and their structure is much too simple to be derived directly from any known pelmatozoan.

June 16.—"On the Relation between the Spectra of Sunspots and Stars." By Sir Norman **Lockyer,** K.C.B., F.R.S.

In a previous paper on the chemical classification of the stars the author suggested the probability that, as the result of further work, the "genera" then proposed might have to be split up into "species." During more recent researches the temperature classification was tested by comparing the relative intensities of the red and ultra-violet ends of the spectra of stars, situated on various horizons of the temperature curve, including Capella and Arcturus, which, according to the original general classification, belong to the same type, viz. "Arcturian." It was found that the spectrum of Capella extended on an average about 70 tenth-metres further into the ultra-violet than that of Arcturus, whilst the red portion of the spectrum is certainly stronger in the latter. That is to say, *the general temperature of Arcturus is probably appreciably lower than that of Capella.*

The next step was to see if chemical change accompanied this reduction of temperature, and if so, whether the change was in any way related to the change from the photosphere to the sun-spot spectrum. In comparing, for this purpose, the spectra taken with the 6-inch Henry prismatic camera, it was noticed that certain lines were relatively intensified in passing from the spectrum of Capella to that of Arcturus.

Similar comparisons of the Fraunhoferic spectrum with the spectra of Capella and Arcturus respectively were next made. This work led to the following conclusions:—(1) That the line absorptions of Capella and the sun are practically identical; (2) that although, speaking generally, the same lines occur in the spectra of the sun and Arcturus, yet in the latter many lines are relatively more intense than in the former. Moreover, in the great majority of such cases *the lines so intensified are probably due to vanadium and titanium.*

Now an analysis of the widened lines observed in sunspots since the year 1894 has shown that the *elements chiefly affected are also vanadium and titanium.*

Thus it will be seen that whilst the temperature classification certainly places Arcturus on a lower temperature level than Capella, and, therefore, the sun, the evidence obtained from a study of the line absorptions of Arcturus and of sun-spots indicates very clearly that the temperature of the Arcturian absorbing atmosphere is about the same as that of the sun-spot nuclei during the above-mentioned period. This conclusion justifies the ideas formulated by De la Rue, Stewart, and Lœwy that the spots are produced by the downrush of cooler material.

Reference is also made to Prof. Hale's suggestion that because the lines which are widened in sun-spots appear as

strong dark lines in Piscian stars, the effect may be produced because sun-spots are more numerous in such stars. From the evidence adduced above it seems a far more probable explanation to suppose that these lines are intensified in sun-spots, and strengthened in those stars which have been placed on lower temperature levels than the sun, because the general temperature conditions are similar. That is to say, the fall of temperature experienced by the metallic vapours in passing from the photosphere to the spot nucleus is of the same order as that to which an absorbing atmosphere is subjected in passing from the temperature conditions of Capella or the sun to those of Arcturus or the lower temperature stars.

"An Experiment Illustrating Harmonic Undertones." By H. **Knapman.** Communicated by Dr. G. J. Burch, F.R.S.

If a vibrating tuning-fork is pressed against a light object such as a piece of paper or a stretched string, this object may follow the vibrations of the fork, contact being continuous. This use of a tuning-fork is mentioned in Lord Rayleigh's "Theory of Sound," § 133. In the present experiment a lightly poised piece of paper is touched by the fork; with small pressure contact may be broken during part of each vibration, and the paper gives a note resembling that of a bowed violin-string, in which harmonic overtones are strong. With still less pressure, contact may be made only at every other vibration of the fork, when the paper gives a note an octave below that of the fork. Similarly, contact at every third vibration of the fork gives the twelfth below, and so on. We thus have the series of harmonic undertones, and with a c'' fork ten or more may be made easily audible.

An optical method of examining the vibrations is also described. A large tuning-fork was made to touch a small card, the edge of which was observed with a lens against a dark background, and appeared to be drawn out into a continuously shaded band, in which stationary positions were visible. The characteristics of various states of vibration were readily perceived.

Geological Society, June 22.—Dr. J. E. Marr, F.R.S., president, in the chair.—The igneous rocks of Pontesford Hill (Shropshire): Prof. W. S. **Boulton.** The hill is a "plagioclinal ridge," bounded on all sides by faults; it is made up entirely of igneous rocks. There are two distinct groups of igneous rocks: a bedded group, consisting of rhyolites and acid tuffs, with andesites and andesitic tuffs, and an intrusive group of olivine-dolerites. The northern end of the hill consists of rhyolite. The andesitic group is made up of felsitic-looking tuffs, passing up into andesitic tuffs, hälleflintas, and lavas. The intrusive rocks are basic and often amygdaloidal; they compare in composition with such olivine-dolerites as those of Rowley, the Clee Hills, and Little Wenlock.—The Tertiary fossils of Somaliland, as represented in the British Museum (Natural History): R. B. **Newton.** The new material described is that in the Donaldson-Smith collection, and one presented by Major R. G. Edwards Leckie. The large Lucinidæ and specimens of Campanile (previously considered as Nerinæa) are typical of Eocene rocks generally, and they agree with the Foraminifera in the Somaliland Limestones in supporting the reference of these rocks to this period. Two limestones seem to be represented in the collections, and appear to be capable of correlation with those of the south-eastern corner of Arabia, as well as with those of Sind and Cutch. Six new species are described and named, and sixteen species or varieties described.—The Caernarvon earthquake of June 19, 1903, and its accessory shocks: Dr. C. **Davison.** This earthquake was the strongest disturbance indigenous to the county for more than five centuries. Its disturbed area contained about 25,000 square miles. The centre of the innermost isoseismal (intensity 7) was situated beneath the sea, about 4 miles west of Pen-y-groes, and the longer axis of the isoseismal ran from N. 40° E. to S. 40° W. It is concluded that the earthquake was caused by a slip of about 16 miles in length along a fault running in the above direction, hading north-westward, and passing either through Clynnog or a mile or two either to the north-west or south-east.

Challenger Society, June 29.—Sir John Murray in the chair.—The **Chairman** exhibited the skeleton of a problematical organism, possibly allied to Heliopora, from the sea bottom off Cuba, and read a letter on its structure from the late Prof. Alleyne Nicholson.—Mr. E. W. L. **Holt** exhibited some new and rare Crustacea from the Atlantic. Mr. Holt also read a paper on the Schizopoda of the North Atlantic and its eastern slope, from the collections by Mr. George Murray in the *Oceana*, by Dr. G. H. Fowler in H.M.S. *Research* in the Færöe Channel and the Bay of Biscay, and by himself in the *Helga* off west Ireland. These collections included a number of interesting novelties, notably among those forms which appeared to live actually on the bottom in deep water, and were caught by a tow-net attached to the trawl-rope.—Mr. Stanley **Gardiner** opened a discussion on the distribution of marine larvæ, in which, mainly from his own observations, he dealt with their length of life in reference to their populating banks and shores in the Indo-Pacific and Atlantic Oceans. He concluded that the larvæ of Crustacea and Echinoderms other than Crinoids may be expected to reach almost any bank, but that results in geographical distribution may be expected from Cœlenterata and Turbellaria, and to some degree also from Chætopoda, Gephyrea, and Mollusca.

Edinburgh.

Royal Society, June 6.—The Hon. Lord M'Laren in the chair.—An obituary notice of Dr. Charles Gatty, prepared by Prof. W. C. M'Intosh, was read.—Dr. E. G. **Coker,** McGill University, Montreal, communicated a paper on the measurement of stress by thermal methods. The paper was experimental, investigating on the one hand the effect of tension upon the coefficient of thermal expansion, and on the other the change of temperature accompanying the application of various kinds of stress. The changes of temperature were measured thermoelectrically, corrections being applied for the loss of heat by conduction, radiation, &c., as the stress was being applied. A number of results were established, the most interesting being, perhaps, the fact that the rate of heat production during the development of the strain continues constant even after the limit of elasticity has been exceeded. As regards the effect of stress on the coefficient of expansion, it was found that there was no appreciable change.—A paper was read on the spectrum of Nova Persei and the structure of the bands, as photographed at Glasgow, by Prof. **Becker.** In the earlier photographs before August, 1901, the spectrum suggested a number of bright bands fading towards the ends and overlapping one another. In the later photographs the bands become detached and suggest a line spectrum in which the lines have broadened into bands. The broadening was found to be proportional to the wave-length, and independent of the nature of the element. The sequence of alternate maxima and minima which characterised the bands, and the distances separating these, were found to be also proportional to the wave-length. This is in accordance with Doppler's principle if we assume the effects to be due to motion in the line of sight. An important part of the paper was devoted to a mathematical demonstration of the correctness of the assumption that the resultant intensity at any point of the plate where several bands are superposed is the sum of the intensities which the radiations would singly produce. The general conclusion was that the spectrum was due to hydrogen and helium.—In a note on astronomical seeing, Dr. **Halm** directed attention to Langley's ingenious method for improving definition in a telescope by agitating the air in the tube. This result, at first sight so contradictory to all preconceived ideas, suggests consideration as to the condition of the atmosphere as a whole when the best definition is obtained. The cause of the blurring is no doubt due to the changes of refraction which accompany the movements of the air. If every portion of the moving air came to its new position with exactly the temperature and density which belong to the new position, there would be no change of refraction and consequently no blurring. Now this state is realised when the air is in a condition of convective or adiabatic equilibrium, and hence definition will be clearer the more

nearly the atmosphere approximates to this condition. Definition is often very good when gales are blowing, and there is no doubt as to the better definition in summer than in winter. These and other cases seem capable of explanation along the lines indicated.

June 20.—The Hon. Lord M'Laren in the chair.—A paper was communicated by Lord **Kelvin** on the front and rear of a free procession of waves in deep water. A solution of the differential equations was obtained which represented a set of standing waves on an infinite sheet of water. At time zero this set of standing waves was conceived as taking place over one-half, to the left (say) of a line drawn parallel to the ridges, while the rest of the surface to the right was initially at rest. The standing waves were then decomposed into two equal processions moving respectively to the right and to the left. At any finite time after there would be a point to the right up to which the motion would be sinusoidal, and beyond which, further to the right, the waves would get flatter and longer. This represented the beginning of a procession of waves advancing into still water. Then to the left of the original line separating the undulating and smooth water there would be associated with the rightward moving procession of sinusoidal waves the tail end of the leftward moving procession. This would give the end of a procession of waves.—Dr. **Ashworth** and Mr. Nelson **Annandale** gave an account of some aged specimens of sea-anemone (*Sagartia troglodytes*) which had been kept in an aquarium in Edinburgh for about fifty years. They are more sensitive than younger individuals to changes of environment, and slower in expanding when conditions again become favourable. They breed very sparingly, while the younger specimens from fourteen to fifteen years old kept in the same aquarium produce hundreds of young. There is only one other recorded case of longevity in cœlenterates, a specimen of the anemone *Actinia mesembryanthemum*, which died in 1887 at the age of about sixty-six. According to unpublished observations of Mr. J. S. Gardiner, the solitary coral *Flabellum rubrum* lives to the age of twenty-four years, while colonial corals, such as Goniastræa, Prionastræa, Orbicella, and Pocillopora, reach the age of twenty-two to twenty-eight years.—In a note on the effect of transverse magnetisation on the resistance of nickel wire at high temperatures, Prof. C. G. **Knott** described a curious result recently obtained. The effect of a strong transverse field is to diminish the resistance, and as the temperature rises the percentage change of resistance falls off very steadily until 280° C. is reached. It begins then to fall off more slowly, passes through a pronounced minimum at about 290°, rises to a sharp maximum at 320°, and then falls rapidly to zero at about 346°. A similar effect, but much less pronounced, is indicated in the author's last published paper on the effect of longitudinal magnetisation.—Mr. J. R. **Milne** exhibited his new design of juxtaposíter for bringing into contact two beams of light in spectrophotometry. The instrument had been made for him by Mr. Hilger, and consisted of a special form of glass prism by means of which two beams of light originally apart were brought accurately with their contiguous edges in contact, each beam having been subjected to exactly the same treatment in the prism. The device could also be adapted to certain forms of polarimeter.

DUBLIN.

Royal Dublin Society, June 21.—Prof. G. A. J. Cole in the chair.—A general method in qualitative analysis for determining the presence of an oxide: Prof. C. R. C. **Tichborne**. The author proposed to use the reaction of phenol-phthalein with acid-carbonate of sodium. Phenolphthalein is colourless in neutral solutions, red with alkaline carbonates, and colourless with acid-carbonates. Most metallic oxides will reduce a certain proportion of the acid-carbonate to the normal carbonate, and the solution then strikes a deep crimson colour if filtered from the oxide and tested with the phenolphthalein. Almost all hydrated oxides and oxides made in the moist way decompose the sodium acid-carbonate solution. Mineral oxides or oxides which have been ignited, with a few exceptions, behave badly in this respect. Ferric oxide and alumina do not act, as the carbonates do not exist. The following oxides will reduce the acid carbonate to the neutral salt of soda:—oxides of lead, silver, bismuth, zinc (ignited and precipitated), copper, antimony, cerium, iron (other than Fe_2O_3), mercury, and tin.—A method for the mechanical analysis of soils: T. **Crook**. The method described is a hydraulic one, and may be regarded as a modification of the Schöne process. No piezometer is used, and the speeds of flow are standardised by varying the size of the outflow aperture and the head of water. The scheme of analysis suggested is a fairly complete one, including the coarser ingredients, as well as the fine earth. The author urges that the object of a mechanical analysis should be twofold:—(1) to enable a moderately definite idea to be formed of the way in which a soil is built up in its natural state; (2) to show something of the physical properties possessed by the soil.—The state in which helium exists in pitchblende: R. J. **Moss**. When pitchblende is reduced to powder in a vacuum, water vapour, helium, carbon dioxide, nitrogen, and oxygen are liberated. Water is the chief substance set free; of the gases, helium sometimes constitutes about half. The helium obtained by rather coarse pulverisation was about 1 per cent. of the total quantity present in the mineral, as determined by fusion with hydrogen potassium sulphate. The carbon dioxide obtained mechanically was less than 1 part in 10,000 of the total quantity present. The results support the supposition that helium exists in pitchblende in the free state, and is contained in extremely minute cavities. A specimen of pitchblende, powdered *in vacuo*, yielded gases containing 0·7 per cent. of hydrogen, which may possibly be a product of the action of radium on the water contained in the cavities of the mineral.—The Rev. H. **O'Toole** exhibited and described an apparatus for determining the expansion of rods, &c., when heated.

PARIS.

Academy of Sciences, July 4.—M. Mascart in the chair.—On certain functional equations and on a class of algebraic surfaces: Émile **Picard**.—Syntheses in the anthracene series. Triphenylanthracene dihydride and its derivatives: A. **Haller** and A. **Guyot**. Two modes of synthesis are given, the one starting from diphenylanthrone and the other from triphenylmethane-*o*-carboxylic acid methyl ester, making use of the Grignard reaction. Both give good yields.—Muscular work and expenditure of energy in dynamic contraction, with gradual shortening of the muscles: A. **Chauveau**.—*Trypanroth* in the treatment of trypanosomiasis: A. **Laveran**. The use of this dye was proposed by Ehrlich and Shiga. The effects produced by this reagent are compared with those of arsenious acid; the two have also been tried in combination, but the general results are disappointing.—On the properties of different substances as regards their ponderable emanation: R. **Blondlot**.—On the seeds of Nevropteris: M. **Grand'Eury**.—Presentation of the fifteenth *Bulletin chronométrique* (1902–1903) of the Observatory of Besançon: M. **Lœwy**.—M. Fliche was elected a correspondant of the academy in the section of rural economy, in the place of M. Lechartier.—On functions representable analytically: H. **Lebesgue**.—On the general theory of networks and congruences: Émile **Martin**.—On a general equality common to all fundamental functions: W. **Stekloff**.—On the stability of aërostats: Henri **Hervé**. Comparative effects of the β-rays and the n-rays, as well as of the α-rays and the n_1-rays, on a phosphorescent surface: Jean **Becquerel**. The radiations emitted by polonium affect a phosphorescent calcium sulphide screen, the action differing according as the radiation has passed through glass or not.—On the kathode rays. A reply to the note of M. Pellat: P. **Villard**.—On the measurement of temperature: Ernest **Solvay**. If two portions of a substance situated near to each other have widely differing temperatures, it is impossible to measure this difference with a thermometer, and a possible case of this kind is given.—On the spectrophotometric estimation of small quantities of carbon monoxide in air: L. de **Saint-Martin**. The instrument measures the ratio between the amounts of hæmoglobin combined with oxygen and carbon monoxide, up to the limit of 1 per cent. of CO.—The determination of the atomic weight of nitrogen by the volumetric analysis of nitrogen monoxide: Adrien **Jacquerod** and St. **Bogdan**.

Pure nitrogen monoxide, prepared from sodium nitrite and hydroxylamine sulphate, was reduced to nitrogen by means of a red hot iron wire, and the change of pressure at constant volume measured. The value 14.019 is deduced from the preliminary experiments as the atomic weight of nitrogen.—Allotropic states of antimony sulphide and their heats of formation: MM. **Guinchant** and **Chrétien.**—The action of ammonia gas upon trichloride, tribromide, and triiodide of arsenic: C. **Hugot.** Arsenic trichloride reacts with ammonia at $-40°$ C., forming arsenic amide, $As(NH_2)_3$. This amide is insoluble in liquid ammonia, but is immediately decomposed by water. The same amide is formed from the bromide and iodide of arsenic. Kept at 0° C., the amide slowly loses ammonia and gives the imide, $As_2(NH)_3$, and this, heated to 250° C., gives the nitride, AsN.—On a method of splitting up fermentation lactic acid into its optically active components: E. **Jungfleisch.** The separation is based on the differences in properties of the three lactates of quinine, and full details of the method adopted are given. Syntheses of pentamethyleneglycol, of the nitrile, and of pimelic acid: J. L. **Hamonet.** The glycol has been obtained from the corresponding dibromopentane, by conversion into the diacetin, and this into the glycol. Pimelic nitrile was obtained from diiodopentane by heating in alcoholic solution with potassium cyanide.—The action of mixed organomagnesium compounds on phthalimide and phenylphthalimide: Constantin **Béis.**—Iodo compounds obtained from metanitraniline: P. **Brenans.**—New synthesis of αα-dimethyladipic acid: G. **Blanc.**—On atmospheric formaldehyde: H. **Henriet.** In a preceding note the amount of formaldehyde existing in the air is estimated to be from 2 to 6 grams per 100 cubic metres of air. M. Armand Gautier has now pointed out that air containing such a proportion of formaldehyde is absolutely irrespirable. The production of carbon dioxide by passing the air over mercuric oxide heated to 250° C. must therefore be attributed to some compound of this aldehyde.—On recent results in porcelain manufacture: F. **Garros.**—On the mechanism of the contraction of muscular fibres, and in particular those of the adductor muscles of lamellibranchs: F. **Marceau.**—On some points in the anatomy of cirripedes: A. **Gruvel.**—The culture of spermatozoids: Alphonse **Labbé.** It is possible for the spermatozoid to commence to develop by itself on a simple culture medium, and away from any organised substratum.—The colours of flowers: G. **Coutagne.**—The question of the cultivation of cotton in tropical Africa: Aug. **Chevalier.**—The presence of hydroquinone in the pear: G. **Rivière** and G. **Bailhache.**—On the lateral roots of the pepper plant: H. Jacob de **Cordemoy.**—New researches on the vegetative apparatus of certain Uredineæ: Jakob **Eriksson.**—On the culture and development of the fungus which produces anthracnosis in the vine: P. **Viala** and P. **Pacottet.**—On the variability of temperature in the Antarctic regions: Henryk **Arctowski.**

NEW SOUTH WALES.

Linnean Society, May 25.—Dr. T. Storie Dixson, president, in the chair.—The botany of south-western New South Wales: F. **Turner.** The characteristics of the indigenous and acclimatised vegetation of the country lying between 35° S. lat., and the Murray or Hume River (the boundary between New South Wales and Victoria), and 141° and 147° E. long., are discussed. The census of the phanerogams and vascular cryptogams now brought forward comprises a total of 379 genera and 949 species.—Studies on Australian Mollusca, part viii.: C. **Hedley.** In August, 1902, Mr. G. H. Halligan and the author made a single cast of the dredge in 100 fathoms, 16 miles east of Wollongong—a depth for the first time attained by local workers. The haul was very successful, and produced a large number of Mollusca. The new species largely duplicated those of the *Thetis* expedition, and were noted during the progress of the report thereon. Other species of interest are now discussed.—The bacterial origin of the gums of the arabin group, xi., the nutrition of *Bact. acaciae*: Dr. R. Greig **Smith.** *Bact. acaciae*, the arabin-former, produces gum readily in the presence of suitable nutrients. Levulose, saccharose, maltose, mannite, and glycerin are sources of carbon, while dextrose, galactose, lactose, and raffinose are not. Dextrose or galactose prevents the gum being formed from levulose or maltose. The organism acquires and readily loses the power of utilising saccharose. It temporarily loses the gum-forming faculty when subcultivated upon sugar-free media. The amides are the best nitrogenous nutrients; a trace of asparagine (0.04 per cent.) is sufficient to produce half the maximum amount of gum. Salts may accelerate, depress or prevent gum-formation. Traces of alkaline citrate or succinate were most favourable. Sumach tannin assists the formation of gum upon artificial agar media. Oak tannin hinders the formation, but the retarding effect may be neutralised by the addition of glycerin. The bacterium might be used to distinguish certain tannins. The tannin probably acts physically by making the medium more contractile, so that the bacteria are slowly supplied with nutrients in solution. The optimum temperature is 17° C. The most suitable medium, as deduced from the experiments, serves as a diagnostic for other gum bacteria. Gum acacia has not a cellulose origin. In the host plant it is formed from the wandering sugars, levulose and maltose. Manuring with saline matters does not promise to be a remedy for the prevention of gum-flux in fruit trees. Peach trees that were inoculated with *Bact. acaciae* (from *Acacia binervata*) developed gum-flux. The exudate was a metarabin gum. The host plant can convert *Bact. acaciae* into *Bact. metarabinum*, proving what had been suspected, that the latter is a variety of the former, producing an insoluble gum. This explains the uniformity of the gums from certain species of trees.—The loss of colour in red wines: Dr. R. Greig **Smith.** Two samples of dry red wine which had exhibited the phenomenon of "*vin tourné*" were found to contain acetic bacteria.

CONTENTS.

THURSDAY, JULY 21, 1904.

THE MIND OF A GREAT THINKER.

An Autobiography. By Herbert Spencer. Two volumes. Pp., vol. i., xii+556; vol. ii., ix+542. (London: Williams and Norgate, 1904.) Price 28s. net.

A GREAT and peculiar interest attaches to these volumes, because in them Herbert Spencer has displayed the steps of the evolution in his own mind of that great scheme of universal evolution which has so profoundly affected modern thought, and has described the mental characteristics that conduced to the conception and the working out of that scheme. Spencer was peculiarly well fitted for the task of self-revelation, and it may safely be said that never before have the mental processes by which a great thinker has produced a vast system of conceptions been so clearly exposed.

The exposition is scattered through more than a thousand pages of matter, much of which is trivial or redundant, and it is perhaps worth while to set down consecutively, and in what seems the order of relative importance, the peculiarities of the philosopher's mind and character which, according to his own account, played a principal part in making the synthetic philosophy just that which it is.

Spencer rightly claims that he possessed in an exceptional degree the three great faculties (1) of deductive synthesis; (2) of analysis, leading to the discovery in complex and seemingly widely different phenomena of the elements or features that they have in common, and so to the inductive verification of large deductions; (3) "the ability to discern inconspicuous analogies."

The first of these was conspicuously manifested at every stage of the development of the system, the earliest considerable display of it being the deduction from the "law of equal freedom" of the conclusions as to political and social institutions presented in "Social Statics." The second was early manifested in the famous essay on "The Universal Postulate," which aimed "to identify the common elements of all those beliefs . . . which we regard as having absolute validity." The third was brilliantly exercised in the discovery of that celebrated analogy which has now become incorporated in common speech in the phrase "the social organism."

These three powers were certainly present in very high degree, and the deductive and inductive tendencies preserved a balance such as is by no means common. But it is possible that many minds have equalled Spencer's in these respects, and the exceptional development of these powers would not have sufficed to give us the synthetic philosophy in the absence of certain other very strongly marked mental traits that contributed to render Spencer's mind peculiarly effective in the carrying out of the great work that he accomplished. Among these the first place must be assigned to the effective belief in universal causation according to immutable laws, a belief early acquired and constantly fostered by the questions put to young Spencer by his father, who rightly considered the leading to a search after causes to be the most important function of the educator. "A constant question with him was,—'I wonder what is the cause of so-and-so';—always the tendency in himself, and the tendency strengthened in me, was to regard everything as naturally caused." The "constitutional readiness to grasp the abstract necessity of causal relations" thus "rendered by practice unusually strong," Spencer himself seems to have regarded, probably rightly, as the most important feature of his intellectual equipment, just as the lack of development, and, in fact, the actual repression, of this tendency, strong in most children, was and still is the gravest defect of English education. Hardly less important was the supreme confidence in his own mental processes, amounting, indeed, to intellectual arrogance, which, at the age of twenty, rendered him desirous of making public "some of my ideas upon the state of the world and religion," and which, a much more exceptional fact, remained unimpaired throughout his long life. There can be no doubt that this was essential to his achievement; by the lack of such confidence many fine intellects are rendered sterile, and had Spencer not possessed it in a very remarkable degree, had he been ever so slightly infected with that diffidence which was so marked a trait of his friend, George Eliot, he would not even have embarked upon a literary career, or, if embarked, he must have remained comparatively unproductive.

Closely allied with this last, and still more closely allied with one another, were the three traits "disregard of authority," "the absence of moral fear," and the tendency to criticise rather than to appreciate, each carried to a very extraordinary pitch. These, generating a repugnance to every kind of statement based upon authority and not appealing to reason for its acceptance, seem to have determined the trend of intellectual activity from the earliest years, from the time when as a small boy Spencer refused to apply himself to the study of Latin or of other languages and at the age of thirteen years rejected the current definition of inertia, to the time when he set aside all religious authority, laid down Kant's "Critique of Pure Reason" rejecting his doctrine of time and space "at once and absolutely" after reading a few pages only, set himself in "Man *v.* the State" in unqualified opposition to the dominant trend of political change, and criticised adversely the frescoes of Michael Angelo in the Sistine Chapel, the compositions of Raphael and of Wagner, the dialogues of Plato and the architecture of Venice.

Important, too, was his persistency in the pursuit of any end, his "tendency . . . to be enslaved by a plan once formed," frequently displayed throughout life in things both large and small. Without this natural persistency he would not have gone far towards the completion of his great scheme in the face of serious pecuniary difficulties and in spite of disturbances of health which, whether they were serious or not, certainly diminished very greatly his capacity for work. In boyhood this persistency was displayed very remark-

ably when he walked from Hinton to Derby, a distance of more than one hundred miles, in three days almost without food or sleep, and its manifestation in later life is well illustrated by the statement that after the projection of the evolutionary system at the age of thirty-seven, "nearly everything I wrote had a bearing, direct or indirect, on the doctrine of evolution."

Among the characters of direct importance to his intellectual productiveness must be reckoned the freedom and spontaneity of his ideational processes. During boyhood trains of ideas were apt to occupy his attention for long periods excluding all awareness of his surroundings, and this seems to have been especially frequent during walking. He speaks of this free flow of ideas in boyhood as "castle-building," but names it "constructive imagination" when, in later life, owing to systematisation of interests, his ideational processes tended towards ends related to his general scheme of conceptions. This spontaneity of the ideational processes enabled him to reach his conceptions and conclusions with a minimum of voluntary effort and, indeed, his efforts were more often directed to the checking rather than, as with most of us, to the promoting of the flow of thought. The following passage describes this as well as another important mental trait.

"It has never been my way to set before myself a problem and puzzle out an answer. The conclusions at which I have from time to time arrived, have not been arrived at as solutions of questions raised; but have been arrived at unawares—each as the ultimate outcome of a body of thoughts which slowly grew from a germ. Some direct observation, or some fact met with in reading, would dwell with me: apparently because I had a sense of its significance. It was not that there arose a distinct consciousness of its general meaning; but rather that there was a kind of instinctive interest in those facts which have general meanings. For example, the detailed structure of this or that species of mammal . . . would leave little impression; but when I met with the statement that, almost without exception, mammals . . . have seven cervical vertebræ, this would strike me and be remembered as suggestive."

In this passage is indicated the last of the faculties of primary importance, the faculty of seizing upon facts or conceptions that were of significance for his scheme of thought, well illustrated by his adoption and extended application of von Baer's phrase "the change from homogeneity to heterogeneity." It was this subtle and ready working of selective attention that rendered unnecessary the storing in the memory of vast masses of facts, and enabled him to dispense with any very extensive reading. Spencer's "sporadic memory" was avowedly poor, and this fact, cooperating in youth with a constitutional idleness, a distaste for continued reading and an impatience of opinions with which he did not agree, and in later life cooperating with an incapacity for reading dating from the time of the writing of the "Psychology" (æt. 38), very effectively preserved him from that "accumulation of knowledge in excess of power to use it" which he deplored as one of the common results of the current educational methods and regarded as one of the principal sources of intellectual sterility in many able men. It is an interesting question, How would Spencer's work have been modified had he devoted much time and energy to reading in place of passing restlessly from place to place, unable to bear solitude, constantly seeking to kill time, as he tells us, by various trivial occupations? Would extensive reading have choked the springs of production? There can be no doubt that, had his mental digestion proved equal to the task, a greater acquaintance with the history of thought would have enabled him to raise his works to a still higher level than that they actually attained—to secure for them an even more solid and enduring fame.

Of the further qualities that especially contributed to determine the character of his political and ethical doctrines, we may note a love of freedom, a quick sympathetic resentment of all injustice, a high valuation of pleasure for its own sake.

As to the general impression of the man produced by this autobiography, it seems certain that it is unduly harsh and unfavourable, for Spencer persisted with almost painful honesty and in accordance with the principle he had adopted, in laying stress upon the distinctive or peculiar features, while neglecting those more amiable traits which he shared with men in general. The result is that, whereas most biographies, and even autobiographies, are of the nature of a portrait, in which the artist selects an aspect and idealises to some extent the features of the subject, this one resembles rather a harsh, crude photograph that reproduces with relentless accuracy, and even gives undue prominence to, the lines and the warts, all the asperities of nature and all the bruises of the battle of life.

W. McD.

AMERICAN BIG GAME.

Musk-Ox, Bison, Sheep, and Goat. By C. Whitney and others. American Sportsman's Library. Pp. 284; illustrated. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1904.) Price 8s. 6d. net.

The Still-Hunter. By T. S. Van Dyke. Pp. viii+390; illustrated. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1904.) Price 7s. 6d. net.

THE members of the deer tribe, together with the pronghorned antelope, or prongbuck, having been described in an earlier volume of the same series, the work standing first in our list completes the account of the wild ruminants of North America. The names of the authors—Mr. C. Whitney for the musk-ox, Mr. G. B. Grinnell for the bison, and Mr. O. Wister for the mountain sheep and the white goat—form a sufficient guarantee that the text of this volume will combine that mixture of sport and natural history for which the true sportsman always looks in works of this nature, and a glance at its pages shows that such is really the case. From title-page to index the method of treatment and the style of writing are admirable, so admirable, indeed, that there is scarcely a sentence to which exception can be taken.

One admirable feature is that all three authors have

agreed to adopt one system of nomenclature, selecting that of Mr. Rowland Ward's "Records of Great Game." Not only is this satisfactory from the point of view of uniformity, but it indicates, in some degree at any rate, a tendency to revolt against the American practice of regarding every colour-phase of an animal as representing a distinct species. Accordingly we find all the American forms of wild sheep included under a single specific heading. In the case of the musk-ox, the author has indeed seen fit to depart from this admirable practice, classing the East Greenland animal as a species apart from the typical *Ovibos moschatus* of the Barren Grounds. Moreover, he is not justified in suggesting that the name *O. m. wardi* (first proposed in our own columns) should give place to Dr. Allen's *O. pearyi*. Doubtless Lieut. Peary has more claim to have a musk-ox named after him than has Mr. Rowland Ward, but if we are to disregard the rule of priority in regard to names of recent origin, zoology will soon be in a state of hopeless chaos.

Since the history of the bison has been written and re-written over and over again, the portion of the present volume dealing with the musk-ox has greater claims to novelty than have the chapters devoted to the first-named animal. Mr. Whitney's account of the extreme difficulties and hardships inseparable from an expedition into the Barren Grounds shows that musk-ox hunting is by no means holiday work, and that even when plans have been most carefully laid, a trip may result in failure even to sight the game. Perhaps it is not generally known that previous to the author's venture the only extensive trips that had been made into the Barren Grounds were those of the two Englishmen, Mr. Warburton Pike and Mr. H. T. Munn.

As a companion to the preceding excellent volume and its fellow in the same series, "The Deer Family," Mr. Van Dyke's "The Still-Hunter" may be heartily commended. Written more exclusively from the sportsman's point of view, it deals in considerable detail with the technique of stalking—or "still-hunting" as our American friends term this kind of sport—and is especially devoted to the pursuit of the white-tailed and mule deer and the prongbuck. As we learn from a statement on the back of the title-page and the preface, this volume is a new and illustrated edition of a work which originally appeared so long ago as 1882 or thereabouts. But it is none the worse for this, since it not only describes American deer-stalking in its palmy days, but is thoroughly up to modern requirements in the matter of rifles and other essentials of sport.

The illustrations, which are both numerous and artistic, are nearly all drawn for a special purpose, and serve to indicate both the impediments and the facilities with which the sportsman is likely to meet in the pursuit of his quarry. While the earlier chapters are devoted to a description of the manner in which to recognise good hunting grounds, and the various methods of tracking and shooting deer, the later ones treat more especially of rifles and how to use them, with a discussion on the type of bullet and the charge of powder best suited to this kind of sport.

If the big-game sportsman who intends to shoot in America be provided with the volume heading this notice and its companion on the "Deer Family," together with Mr. Van Dyke's "Still-Hunter," he may consider that, so far as literature is concerned, he is thoroughly equipped for his task. The first two volumes have, in addition, no small amount of interest for naturalists of all countries. R. L.

THE ORBIT OF A PLANET.

Grundriss der theoretischen Astronomie und der Geschichte der Planetentheorien. Zweite vermehrte Auflage. By Prof. Johannes Frischauf. Pp. xv + 199. (Leipzig: Wilhelm Engelmann, 1903.)

THE title of this work is too comprehensive; an outline of theoretical astronomy might be expected to touch at least gravitational theory, even if other physical sections were omitted. Prof. Frischauf's work—the first edition of which appeared in 1871—is engaged almost exclusively with the geometrical problem of finding an orbit from observation, and with a detailed history of Kepler's search for the true form of a planet's orbit. It is intended as an introduction, and is not ambitious for completeness; indeed, it omits many things a student might well be told, which would not have broken its attractive readable quality. For example, there are many better approximations for solution of Kepler's problem than that given on p. 6, and the well known graphical solution with the help of the curve of sines is not mentioned; this should not be omitted, for it is a method of real utility, and with proper care can be worked, as Bauschinger says, with an error not exceeding a tenth of a degree.

The author is well advised in following Gauss closely; it is almost inevitable that the work should be largely composed of excerpts from the *Theoria Motus*, and a writer serves his readers best who does not disguise them. But the numerical examples would have gained by being less faithful. The practice of astronomers in their reductions has undergone very great changes, and justice is not done to it by a note such as that at the bottom of p. 74, where, in reference to certain places of the sun extracted by Gauss directly from the tables—von Zach's presumably—Prof. Frischauf explains that our procedure is now less primitive.

Those who prefer to read Gauss and Olbers in the original, or in the masterly handbooks of Watson or Oppolzer, will find plenty to interest them in the third part of this work. Under a title of the history of the planetary theory, Prof. Frischauf gives, along with a cursory account of the rest of the history, a most interesting detailed story of Kepler's successive efforts to obtain the true form of a planet's orbit. Prof. Frischauf remarks that there are few more interesting pieces in the history of science; yet very few authors have allowed themselves space to do it justice. Dr. Frischauf, as professor at Gratz, is the appropriate man to write upon Kepler, for Kepler himself was a lecturer on mathematics at Gratz, and there made his name as an astrologer. The penetration of the older theories deserves more recognition than it gets; it is but little known how

well true elliptic motion can be simulated by an eccentric circle *and* Ptolemy's equant. The equant is a point about which motion in the circle appears uniform. In elliptic motion it may be easily seen that the empty focus is approximately such a point. Using the equant, the maximum error in longitude is only one quarter the square of the eccentricity—8′ only for Mars, and for the other planets, except Mercury, less than 2′. But if any reader wants to know all the equant can possibly be made to do before it must be condemned, let him read this account of Kepler's efforts.

OUR BOOK SHELF.

The Fourth Dimension. By C. Howard Hinton, M.A. Pp. viii+247; with coloured frontispiece. (London: Swan Sonnenschein and Co., Ltd., 1904.) Price 4*s.* 6*d.*

A book bearing the present title may be reasonably expected to contain certain things. In the first place it should have a clear exposition of Descartes's applications of algebra to geometry, and conversely of geometry to algebra, the logical conclusion of which consists in the removal of all restrictions as to the conceivable number of dimensions of space. In the second place it should contain clear, concise, and exactly worded statements of the peculiar and distinctive geometrical properties which are characteristic of spaces of two, three, four, or more dimensions respectively. Among these peculiarities might be cited, as examples, the number of possible regular figures corresponding to the five regular polyhedra of three-dimensional space, the number of independent motions of a rigid body, the properties analogous to those of the shortest distance between two lines, the symmetry of crystals, and, in short, any results calculated to convince the reader that the study of space not only of four, but of *five, six*, and generally *n* dimensions leads to the discovery of geometrical theorems no less interesting than those of ordinary plane and solid geometry.

Now such things as these are either entirely absent from the book or else they are mixed up with such a mass of irrelevant and discursive matter as to render it often quite impossible to make out what the author is driving at. The notion of a fourth dimension is associated with the belief in a higher world with electricity and magnetism, with organic life, with logic and philosophy, with the nature of the human soul, and with a variety of other ideas only calculated to mislead the reader as to the real use of such inquiries. It is doubtful whether any tangible idea of the "eight cell" or any other four-dimensional figure can be gained by mere playing with coloured squares or cubes. The proper way to realise the nature of such figures is by studying their projections on pairs of coordinate planes, and four-dimensional space has the great advantage over three-dimensional in that any figure formed of points can be completely represented by projections on two sheets of paper, whereas for a three-dimensional figure one sheet is insufficient and two sheets are too much.

There is a certain class of individual, far too common in this country, who busies himself in pestering his mathematical friends with long and rambling letters on such questions as "What is the fourth dimension?" or "What is the ether?" Such people very rarely know anything about the three dimensions of the space they live in, but Mr. Hinton's book will, it is to be hoped, give them something to think about which will at least amuse them and keep them occupied. The great misfortune is that such books are believed by the general public to be descriptions by a mathematician of the work of other mathematicians. Consequently, mathematicians obtain a reputation for being unpractical which they certainly do not deserve.

The Hill Towns of Italy. By Egerton J. Williams, jun. Pp. xiv+398; with illustrations from photographs and map. (London: Smith, Elder and Co., 1904.) Price 10*s.* 6*d.* net.

The majority of English people who visit Italy confine their attention to large towns such as Florence, Rome, Naples and Venice. The mediæval towns of Etruria and Umbria constitute practically a *terra incognita* to the ordinary tourist. The author has done useful work in directing attention to a district full of historic associations, and the picturesque glimpses which he has given us both of towns and country may well tempt those who have the time and opportunity to go and visit the district themselves.

If there is one feature which lends itself to criticism, it is that a perusal of the book does not give one a mental picture so much of the towns themselves as of an American *traveler's* impressions of them. It is probably very hard for any writer to describe Italian life who has not spent several of his early years in Italy. So long as the writer confines himself to purely descriptive matter the facts are Italian enough, but where he endeavours to give colour to the scene, that colour hardly feels right. We may cite such sentences as "The exquisite grace and sweetness of the madonna hold the onlooker like a vise" (query *vice*); "One more ancient madonna greeted me as I passed out by the left aisle." It would also be interesting to know the author's authority for such spelling as Velathri and Thrasymene. Velitrae and Trasimene are certainly usual. Seeing, however, that the book was written as the result of only a sojourn of a spring and summer among the hill towns, we can but be surprised at the amount of interesting matter which it contains.

Our Mountain Garden. By Mrs. Theodore Thomas. Pp. 212. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1904.) Price 6*s.* 6*d.* net.

Suburban gardeners sometimes attempt, with less or more success, generally less, to establish a mountain in the back garden. The author of this book has adopted the converse plan of establishing a garden on a New Hampshire mountain side. In this little book she tells us how she did it, what patience she exercised, what disappointments she experienced, what ultimate success she achieved.

The story is well told, and it is obvious that the gardener was not only successful, but that she deserved to be.

Nevertheless, her sympathies seem rather to be with the birds and wild animals to which she acted as hostess than with the plants she used for decoration. She seems to have looked on the plants as so many cakes of colour, useful for producing effect, but to have ignored the mental refreshment which a more thorough study of their peculiarities and of their manners and customs would have afforded.

Her "practical hints" are excellent, and will be serviceable to those disposed to follow her example and make a garden for themselves according to their own notions.

The list of shrubs, flowers, and weeds cultivated is disfigured by an unusual number of printer's "weeds," though it is scarcely fair to the "compositors" to attribute to them errors for which the author ought to be held responsible. If the book should, as is very likely to be the case, appear in a second edition, it is to be hoped that this list will be revised by someone familiar with the names of plants and with the way in which they should be spelt.

Guide to the Analysis of Potable Spirits. By S. Archibald Vasey. Pp. ix + 87. (London: Baillière, Tindall and Cox, 1904.) Price 3*s*. 6*d*. net.

THE analysis of potable spirits has within recent time acquired increased importance on account of the attention now given by medical men and others to the characters of potable alcohol, and also on account of the action of inspectors under the Sale of Food and Drugs Acts in connection with the attempts which are being made by various local authorities throughout the country to put a stop to the misdescription of spirits. The Acts under which the Excise authorities work unfortunately contain no adequate definition of such articles as whisky and brandy, and this omission has undoubtedly facilitated the manufacture of factitious spirits. At the present time there is practically no official control over the sale of ardent spirits beyond ensuring to the customer, solely in the interest of the Revenue, that their alcoholic strength shall not be below a certain minimum. The Revenue authorities are not concerned to know whether what is called whisky is a pot-still or a patent still spirit, whether it is made from raw grain or malt, or whether it is old or new. To them it is a matter of little moment whether what is called brandy is genuine grape spirit, or whether it is a rectified spirit obtained from maize or potatoes, flavoured with so-called essence of brandy and coloured with caramel.

Those who trade in these things are, however, taking steps to ensure that purchasers who, in the words of the Act, are entitled to be supplied with articles "of the nature, substance and quality demanded," shall be served with genuine grape-spirit when they ask for "brandy," and the Sale of Food and Drugs Acts have been set in motion to secure this, and convictions under their provisions have already been obtained. Now that a decision of one of the higher courts has been given, confirming those of the courts below, the local authorities will doubtless continue to take action, and public analysts will probably be very busy with such cases. Mr. Vasey's book, therefore, appears at an opportune time, and may be recommended to the notice of all who are interested in the subject of differentiating spirits.

Forestry in the United Kingdom. By Prof. W. Schlich, F.R.S. Pp. 72. (London: Bradbury, Agnew and Co., Ltd., n.d.)

THIS book gives a very able exposition of the pressing need of extended and improved forestry in the United Kingdom. It deals with certain important points already discussed, as the author informs us, in lectures at various centres. Prof. Schlich sets forth a very strong case in favour of the better management of British woodlands. His arguments, supported by very convincing statistics, are such as should meet with the approval and support of all interested in the subject. The problem of how to utilise to the best advantage our enormous acreage of waste land is ably dealt with, and in our opinion settled by the author in chapter iii. This chapter contains a most interesting discussion on the conflicting interests of forests and game preserves; Prof. Schlich, however, shows how these may be reconciled. The chapter also contains numerous practical hints and yield tables showing the financial return to be expected from properly managed woods. We cannot close this notice without mentioning the excellent series of photographs illustrating the natural regeneration of beech, the production of high-class oak timber, and the proper density of spruce woods. The photographs have been judiciously chosen by the author, and included to show what result can be achieved when forests are treated in a rational and systematic manner.

Ready Reference Tables. Vol. i. Conversion Factors. Compiled by Carl Hering. Pp. xviii + 196. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 10*s*. 6*d*. net.

THIS is the first of a series of reference tables which Mr. Hering has in course of preparation, and which are intended to contain all the data most generally required by engineers and physicists. The author has aimed not only at making the tables handy for reference, but also at making them complete and accurate to a degree not usually attained by pocket books. Thus in the present volume the conversion factors are given to six or more significant figures, their reciprocals are given, and also seven-figure logarithms. This is a degree of accuracy which can be but rarely required, and in deference, we suppose, to the practical engineer, the author has added approximate fractional values; everyone, therefore, should be able to find what he wants. All the values have been most carefully re-calculated and checked from the various legal definitions, thus making the data authoritative. The value of the book as a standard for reference cannot be questioned; the arrangement is more open to criticism, and we cannot help thinking that the method of tabulation adopted, which is to arrange all the tables in order of the size of the quantities, results in an unnecessary amount of repetition. For example, the same factor is repeated five times (with a change only in the position of the decimal point) for converting respectively milligrams, centigrams, decigrams, grams, and kilograms into grains. If this is really desirable, it should be consistently followed out; yet one finds the grain expressed only in terms of the milligram, centigram, and gram, the decigram only in terms of the grain and gram, and not otherwise mentioned in the table. The result is that one hardly knows where to look for what one wants, which considerably detracts from the merits of a compilation excellent in all other respects.

M. S.

A Compendium of Chemistry (including General, Inorganic and Organic Chemistry). By Dr. Carl Arnold. Translated by John A. Mandel, Sc.D. Pp. xii + 627. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 15*s*. net.

THIS kind of book is perhaps more common and more popular, therefore, in Germany than in this country. It is neither a text-book nor a book of reference, but something between the two. Its aim seems to be rather to refresh the memory, if the word refresh can be used in this connection, than to train the mind. It is, in fact, a *multum in parvo* of information, which a student who had worried out his principles and theories beforehand, and merely required to marshal his facts and ideas, might use with advantage.

For example, the whole of chemical theory, including physical chemistry, is served up in the first hundred pages in a series of small doses of concen-

trated extract. There is a capsule of chemical statics, of dynamics, of physical mixtures, of thermochemistry, of electrochemistry, &c. The same concentrated form of diet is continued throughout the volume unrelieved by any historical references or illustrations of apparatus.

There are numerous little inaccuracies, both of author and printer, which it would be well to correct in a future edition. J. B. C.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Residual Affinity.

SIR OLIVER LODGE and Prof. Frankland have indicated (pp. 176, 222) the way in which the electronic theory may afford an explanation of various chemical phenomena; notably so in the case of solutions: the apparent dissociation of the ions of the solute being a consequence of partial withdrawal of the bonds or electric charges uniting them, these bonds becoming occupied in connecting the ions with the molecules of the solvent, and dissociation into ions being thus a consequence of the chemical affinity of the dissolved substance for the solvent, instead of being a proof that no such thing as chemical combination exists in a solution.

I should like to point out that this view was developed by the writer nearly thirteen years ago in a paper entitled "The Theory of Residual Affinity as an Explanation of the Physical Nature of Solutions," which appeared in the *Berichte*, 1891 (pp. 3629–3447), and of which some account will be found in the last edition of Watts's "Dictionary of Chemistry" under the head of "Solutions," p. 495. The only difference in the explanation there given from that given by Sir Oliver and Prof. Frankland is that the atomic charges were spoken of as fluid charges surrounding the atoms instead of as Faraday bundles.

The view that the charge uniting atoms in a molecule is a variable quantity was developed by the writer at a still earlier date in a paper on atomic valency, read before the Chemical Society, December 3, 1885, but printed privately only; a further view was propounded in that communication that the bonds or charges of atoms of a different nature were not exactly equivalent to each other, and were not necessarily expressible by whole numbers. Such a view gives a somewhat striking explanation of many chemical facts which are otherwise difficult of explanation, but it is independent of the explanation of the nature of solutions given subsequently, and now put forward by Prof. Frankland, the basis of which is the mobility and divisibility of the atomic charges. SPENCER PICKERING.

Harpenden, July 10.

A Volatile Product from Radium.

IN the course of some recent experiments on the excited radio-activity from the radium emanation, some evidence has been obtained which points to the conclusion that the emanation X of radium at one stage of the changes which it undergoes after being deposited on a solid body is slightly volatile even at ordinary temperatures. The effect which gives rise to this conclusion was first noticed in some observations on the rate of decay of the part of the excited activity deposited on a plate of copper immersed for a short time in dilute hydrochloric acid, in which the activity from a platinum wire exposed for a time to the radium emanation had been dissolved. When the copper plate with its active deposit had been placed inside a testing vessel and removed after a few minutes, it was noticed that a temporary activity, in some cases equal in amount to one or two per cent. of the activity of the plate, was excited on the walls of the vessel. This activity increased to about three times its original value in the course of thirty minutes after the removal of the active copper, and then decayed regularly to zero.

The amount of this radio-active deposit that can be obtained from a given amount of the direct radium excited seems to be increased by the solution and re-deposit of the emanation X, but it can also be observed from a wire just removed from the radium emanation. If the active wire is placed at once in the testing vessel without having had its temperature raised in any way and removed in a few minutes, an activity about 1/1000 of the whole activity shows itself on the walls of the vessel. The decay of the activity of this deposit is the same as that of the deposit obtained from the active copper. The following table gives the rate of change of the radiation from the walls of a vessel in which an active wire had been left for three minutes after its removal from the emanation:—

Time after removal in minutes ...	1	5	10	20	25	30	35	40	50	60
Activity	40	61	75	96	99	100	98	95	88	78

The active wire retains this power of exciting secondary activity for only a short time after removal from the emanation; after ten minutes the amount it excites is almost inappreciable. Merely washing the wire in a stream of running water and drying it over a gas flame, as is frequently done to prevent any trace of radium emanation clinging to the wire, increases the amount of the secondary activity to about 1/200 of the whole.

It is evident, then, that some sort of volatile product is given off from the active wire for a time which can excite an activity the rate of decay of which would indicate two changes in the active matter deposited, one producing rays and the other not giving rise to any radiation (E. Rutherford, "Radio-activity," p. 269). It is found that this volatile substance responds to none of the three tests for an emanation, it is not itself radio-active, it cannot pass without sensible loss through material substances such as paper and cotton-wool, and the activity due to it is not concentrated on the negative electrode in an electric field, but distributes itself evenly over all surfaces exposed to it.

The decay of the excited activity from the radium emanation has been explained by Prof. Rutherford on the assumption that there are three changes in the emanation X after its deposit on a solid body. In these three stages one-half the matter is changed in 3 minutes, 21 minutes, and 28 minutes respectively. In the first and third stages the change is accompanied by ionising rays, but the second is a rayless change. Now if it be supposed that after the first change has taken place the matter becomes slightly volatile, and some of it is concentrated on surrounding objects, a deposit would be obtained which would present the two remaining changes. From the equations for the radio-activity of such a deposit ("Radio-activity," p. 271), it is found that the radiation would increase for about 34 minutes, pass through a maximum, and then decay at the ordinary rate. This is very similar to the behaviour of the deposit obtained in the above experiments.

Curie and Danne (*Comptes rendus*, March 21) have obtained deposits showing similar characteristics by heating a radio-active wire within a cylinder and measuring the rate of decay of the activity of the cylinder. HARRIET BROOKS.

McGill University, Montreal, June 28.

The Traction of Carriages.

IT is a matter of general belief amongst drivers, owners, and builders of carriages that if the distance between the fore and hind wheels be increased so will the "draught" be heavier. I have put the following case before a builder: given two carriages weighing exactly the same, with the fore and hind wheels of each of the same height, but the body of one carriage much longer than that of the other, then the horse will have as much to do in the one case as in the other. The answer has been in more than one instance, the longer bodied carriage will be the heaviest to move. No reason has been given, nor can any explanation of the existence of this belief be offered. Can any of the readers of NATURE make any suggestion? E. WILLIAMS.

Ross, July 17.

UNIVERSITIES AND THE STATE.

THE deputation which was received by the Prime Minister on Friday last put forward a plea for the State endowment of universities which has been accepted by leading nations as a fundamental principle of progress. The influence of this principle upon the development of nations was shown by Sir Norman Lockyer in his address to the British Association last year, and the deputation was organised by the Association as the natural outcome of this address.

It would scarcely have been possible for a case to have received more impressive support than was given to it by the representatives of universities, industries, national and local interests who responded to the appeal issued by the British Association as to the need for recognition of the responsibility of the State for higher education and research. Of the four hundred people who expressed the sympathy of the bodies or organisations they represented with the manifesto sent out by the Association, only two hundred could be received by the Prime Minister, but these included leaders in many departments of national activity.

In introducing the deputation, the importance of the State endowment of universities was urged by Sir Norman Lockyer, as presented in his address. That university authorities hold the same view as the men of science and political leaders was shown by Prof. Pelham, representing Oxford; the Vice-Chancellor of Cambridge; and Mr. Chamberlain, who spoke for the new universities. The importance of applications of science was represented by Sir W. H. White and Sir W. Ramsay; the importance of the humanities by Sir R. Jebb; and the importance of research by Sir Henry Roscoe. Mr. A. Moseley spoke on American science and industry, and Mr. Bell, M.P., speaking in the absence of Mr. Burt, M.P., pointed out the importance of the reduction of fees and complete educational organisation, and showed by his presence that the State endowment of universities is approved by the artisan classes of the country.

In replying to the deputation, Mr. Balfour acknowledged that the endowment of universities assisted a nation in the industrial struggle, and that there is a great need, both in the new and the old universities, for help toward this object. The Chancellor of the Exchequer said that he would double the grant for university colleges this year, and he hoped to be able to redouble it next year; but before considering any larger contributions to university education he would like an exposition from the universities themselves as to the extent they were prepared to come under control if they received grants. He referred to the additional grant of 75,000*l*. a year to university colleges (representing a capital sum of 3,000,000*l*. at $2\frac{1}{2}$ per cent.) as having already been given as the result of the appeal made last year by the president of the British Association. From this it seems quite clear that if the university colleges had been content to wait until the general appeal was made, the result might have been better all round—so far as the early grant of money is concerned.

As the general result of the deputation, we may therefore take it that the principle of State endowment of universities has been conceded, and that the Government is prepared to deal with the question in a liberal manner when the universities have expressed their views as to control, and the finances of the country permit large contributions to be made.

The manifesto issued by the British Association was as follows:—

Statement prepared by the president of the British Association and revised by a committee consisting of the Deputy Vice-Chancellor of the University of Oxford, the Vice-Chancellor of the University of Cambridge, Sir Oliver Lodge, principal of the University of Birmingham, Sir Michael Foster, M.P., and Sir Henry Roscoe.

THE NATIONAL NEED OF THE STATE ENDOWMENT OF UNIVERSITIES.

(1) The British Association has taken action regarding the State endowment of universities, because at the present juncture the highest education and research is a matter not merely of academic but of the gravest national concern.

There is now a general opinion that Britain is in danger of falling behind in the industrial competition now going on between the most highly civilised States.

The university no less than the primary school is in question, because we are in the midst of a struggle in which science and brains take the place of swords and sinews; the school, the university, the laboratory and the workshop are the battlefields of this new struggle, and the scientific spirit must not be limited to the workshop, since other nations utilise it in all branches of their administration and executive.

The more our legislators, administrators and executive officers possess the scientific spirit, and the more the rule of thumb is replaced by scientific methods, the more able shall we be to compete successfully with other countries along all lines of national as well as of commercial activity.

It is a question of an important change of front, of finding a new basis of stability for the Empire in face of new conditions; and since the full life of a nation with a constantly increasing complexity, not only of industrial but of high national aims, depends upon the universal presence of the scientific spirit, of brain-power, our whole national life is involved.

The Function of a University in a Modern State.

The men upon whom the nation must chiefly depend for aid under the complex conditions of the modern world must not be entirely untrained in the study of the nature and causes of the things which surround them, or of the forces which have to be utilised in our daily life; their training and education in humanities must also have been of the widest.

Such men cannot be produced either by a university which neglects science or by a technical college which neglects the humanities.

Hence the universities must be enabled to combine these two sides of a complete education, and they must also be enabled to foster research along both lines, for research is the highest and most important instrument of education, as well as its most valuable result. When science and its applications were of less importance than now the humanities sufficed and university requirements were small; rooms, books, and a small number of teachers of a small number of subjects comprised the essentials of the university. Modern university needs have been too much regarded from this old standpoint.

All this is now changed. For instance, in the most modern German university the buildings, all elaborate and all differing from each other, have already cost a million, and still the university is not complete. Books have to be supplemented by expensive instrumental equipments, which constantly have to be added to or replaced, and by utilising this new material the fruitful ramifications of learning have increased fifty-fold, and the teachers naturally in even greater proportion.

The extraordinary thing is not that a claim to meet

these new conditions is made now, but that we have waited so long for it in this country while other countries faced them long ago.

The Money.

Money is required at the present moment for:—

(1) Buildings and equipments for pure and applied science in both old and new universities.

(2) Pay and pensions of an increased number of professors, demonstrators, &c., in pure and applied science in both old and new universities.

(3) Strengthening of science teaching and research in all, and of the humanities in the new universities.

(4) Reduction of fees, and the wide educational enfranchisement of proved ability in all classes.

Hitherto universities have looked mainly to private endowments. Universities have been regarded too much as luxuries of the rich, and perhaps on this ground higher education has been treated by the Government as of trivial importance to the nation, as a thing it may properly disregard.

Judging from the action taken in other countries, it is safe to say that private endowment has not produced more than 10 per cent. of the money actually needed in Britain.

Nor can we rightly appeal to local rate-aid alone. It would be unjust to expect certain restricted localities to provide universities which, if we are to go on, must be utilised by the whole Empire.

We are driven then to the State. The other civilised States largely endow their universities; Germany, with an aggregate income less than ours, spends roughly a million a year on its universities. The University of Berlin alone received more than 168,000*l.* from the State in the year 1891–2. In the United States, in addition to 200,000*l.* a year received from the Government, the States supply 700,000*l.* in the aggregate and private endowment 2,000,000*l.* The University of Tokio receives 130,000*l.* a year from the Government of Japan.

These figures derive their chief importance from the fact that these magnificently endowed and State-aided universities are the institutions we are contending with in the production of men to do the nation's work along all the lines of its activities.

But the large sums available for the efficient working of the German and American universities are not alone in question. The number of universities in Germany is nearly double that of the British universities. The number of first-class universities in the United States, where, as Mr. Choate has told us, education is the chief business of the nation, is nearly four times that of the British universities.

Can we Afford to Spend Money on Universities?

Britain's great needs at the present moment are brain-power to invigorate our commerce, among other things, and sea-power to guard it, among other things. The State has recently spent 120,000,000*l.* to bring our Navy up to date; it has not yet spent a single million on our universities.

Sir Robert Giffen has stated that the yearly income of the people of the United Kingdom may be taken as not less than 1650 millions, and their aggregate expenditure a few years ago was not less than 1,400,000,000*l.*, including 30,000,000*l.* for education, which is less than 2 per cent. of the whole. The amount borne on the estimates for education is about 13,000,000*l.*

He writes:—"The country should be spending 100 millions where it now spends 30, or about 5 per cent. . . . Such sums are not really extravagant. Extensive diffusion of education and scientific knowledge and training are not only essential to the greater efficiency of labour and capital by which the means of living are provided, but they are equally needed for the conduct of life itself, for the health and comfort of the workers."

It cannot be doubted that the expenditure will be quickly remunerative. More efficient workers will produce more.

Money so spent is seed from which a harvest can be looked for; the plentifulness of the crop will depend upon the seed and the way it is sown.

One of our manufacturers who has been most successful in applying science to industry has stated that if we were now to borrow 10,000,000*l.* for university purposes we should get the money back in the course of one generation a hundred-fold.

The recent recognition of the fact that we have too few universities, and that those that we have are inefficient for want of funds, is similar to that awakening which occurred in 1888 regarding the Navy. In both cases we have to correct past mistakes lasting for years, and seeing that university buildings, as well as annual endowments, are required, some special provision should be made for their early erection.

The Universities in Relation to Secondary Education.

Now that the primary and secondary schools throughout the country are being coordinated, the time has arrived for making our universities and university colleges efficient. The teaching connected with the universities must be of the highest, and the chief function of the secondary schools should be to produce students possessing that general training in science and the humanities which will ensure the success of their subsequent careers, either inside or outside a university.

A system of leaving certificates and a reduction of fees would at once get rid of the tyranny of merely qualifying or selecting examinations which are the bane of education, and would enable the training of the poorest to be carried to the highest rung of an unbroken ladder.

The deputation which advocated these views included representatives from the universities and university colleges, and from county, municipal and other educational authorities in Great Britain and Ireland, Canada and Australia. The list of the deputation contained the names of some who intended to be present, but were prevented from attending. Lord Rosebery, for instance, was unable to attend as Chancellor of the University of London; but with the exception of Oxford, Cambridge, and London, the chancellors of all the universities appear to have formed part of the deputation. A very large number of members of Parliament were present; and it is not too much to say that every important body of opinion—social, industrial, and intellectual—was represented. Among the members of the deputation were the following:—

The Vice-Chancellor of Oxford University, the president of Magdalen College, the president of Trinity College, Prof. Poulton, Prof. Miers. The Vice-Chancellor of Cambridge University, Sir R. C. Jebb, M.P., Mr. A. E. Shipley, F.R.S., and Prof. Forsyth, F.R.S.

The Vice-Chancellor (Dr. Pye-Smith) of London University, Sir Edward Busk, Sir Arthur Rücker, Sir Henry Roscoe, and Prof. Unwin. Sir John Aird, Bart., M.P., Sir G. C. T. Bartley, K.C.B., M.P., Sir M. M. Bhownaggree, M.P., Lord Hugh Cecil, Mr. W. R. Cremer, M.P., Sir M. Foster, K.C.B., M.P., Mr. Ernest Gray, M.P., and Dr. T. J. Macnamara, M.P. The chairman of the London County Council, and the chairman of the Education Committee of the L.C.C. Masters and wardens of the Fishmongers', Goldsmiths', Skinners',

Merchant Taylors', Ironmongers', and Vintners' Companies. Lord Reay, Hon. W. F. D. Smith, M.P., Lord Edmond Fitzmaurice, M.P., Sir William Hart Dyke, M.P., Mr. James Bryce, M.P., Sir Donald Currie, and Lord Stanley of Alderley. The principal of University College (Dr. Carey Foster), the principal of King's College (Dr. Headlam), Lord Macnaghten, the Bishop of London, the Bishop of Rochester, Sir John Wolfe-Barry, K.C.B., F.R.S., Mr. A. H. D. Acland, and Mrs. James Bryce.

Durham University was represented by Lord Londonderry, Earl Percy, the Bishop of Durham, the Dean of Durham, Principal Gurney, Lord Armstrong, Hon. C. A. Parsons, F.R.S., and Sir E. Grey, Bart.

The Chancellor of Victoria University, Manchester (Earl Spencer, K.G.), the Lord Mayor of Manchester, Sir J. T. Hibbert, K.C.B., Sir William Houldsworth, Bart., M.P., Sir James Fergusson, Bart., M.P., Sir J. Hoy, Sir Frank Forbes Adam, Prof. Schuster, Prof. Dixon.

The Chancellor of Leeds University (Marquis of Ripon, K.G.), Lord Wenlock, chairman East Riding Council; Mr. Herbert Gladstone, M.P.

The Chancellor of Liverpool University (Earl of Derby, K.G.), Prof. Boyce, F.R.S., Sir J. T. Brunner, Bart., M.P.

The Chancellor of Birmingham University (Mr. Chamberlain), Sir Oliver Lodge, Sir A. Hickman, M.P., Lord Cecil Manners, M.P., Sir P. A. Muntz, M.P.

The Bishop of Hereford, president of University College, Bristol; Prof. C. Lloyd Morgan, F.R.S., the Right Hon. Lewis Fry, Sir Frederick Wills, Bart., M.P., and Mr. C. E. Hobhouse, M.P. Alderman J. Bright, J.P., chairman of council of University College, Nottingham; Lord Henry Bentinck, M.P., and Sir F. A. Milner, M.P. Mr. J. H. Benyon, president of University College, Reading. The Duke of Norfolk, K.G., president of University College, Sheffield; Sir Fredk. Mappin, Bart., M.P., Dr. Hicks, F.R.S., Sir W. H. Holland, M.P., and Sir Howard Vincent, M.P. The Duke of Wellington, K.G., president of Hartley University College, Southampton; and Lord Northbrook, chairman Hampshire County Council.

The Head Masters' Conference, Rev. Dr. Gow. The Head Masters' Association, Canon Bell, Dr. McClure. The Assistant Masters' Association, the chairman, Mr. G. F. Daniell; vice-chairman, Mr. R. F. Cholmeley; and others.

The British Association for the Advancement of Science, the president, Sir Norman Lockyer, K.C.B., and the treasurer. The Royal Academy of Arts, the president, Sir Edward Poynter, R.A. The Society of Arts, Sir W. de W. Abney, K.C.B., F.R.S. Institution of Civil Engineers, Sir William H. White, K.C.B., F.R.S. Iron and Steel Institute, the president. The Society of Chemical Industry, Sir William Ramsay, K.C.B., F.R.S. Associated Chambers of Commerce, the president. Association of Municipal Corporations, Sir Albert Rollit, M.P. County Councils Association, Sir John T. Hibbert, K.C.B.

The Vice-Chancellor of the University of Wales (Principal Griffiths, F.R.S.), Lord Rendel, Sir Lewis Morris, the Right Hon. Lord Kenyon, Prof. R. W. Phillips, Prof. W. Rhys Roberts, the Lord Lieutenants of many counties, the Right Rev. the Lord Bishop of Llandaff, the Right Rev. the Lord Bishop of St. David's, and the president of the Miners' Federation.

The principal of the University of St. Andrews (Dr. James Donaldson), the president of University College, Dundee (Earl of Camperdown), and Sir John Long, M.P. University of Glasgow, Prof. G. G. Ramsay, Prof. Thomas McCall Anderson, Sir John Stirling Maxwell, Bart., M.P., Sir Herbert E. Maxwell, Bart., M.P. University of Aberdeen, Sir George King, K.C.I.E., F.R.S. University of Edinburgh, the Vice-Chancellor and principal, Sir William Turner, K.C.B.

The Chancellor of the University of Dublin and Trinity College (Earl of Rosse, K.P., F.R.S.), Lord Rathmore, and the provost of Trinity College (Dr. Traill). The Vice-Chancellor of the Royal University of Ireland (Right Rev. Monsignor Molloy). The president of Queen's College, Belfast (Dr. Hamilton), the Lord Mayor of Belfast. The president of Queen's College, Cork (Sir Rowland Blennerhassett, Bart.). The president of Queen's College, Galway (Dr. Alex. Anderson). The president of University College, Dublin, Catholic University of Dublin (Rev. W. Delany, S.J.).

Principal Petersen, the McGill University, Montreal. Prof. A. Liversidge, University of Sydney.

Limitations of space will not permit the publication of a complete report in these columns, but the subjoined extracts from the speeches will convey an idea of the points raised. After the deputation had been briefly introduced by Sir Norman Lockyer, Prof. Pelham, speaking on behalf of the Hebdomadal Council of the University of Oxford, said:—

We are here to express our entire sympathy with the main object of this deputation. The older universities welcome this opportunity of standing in line with the newer universities which are growing up around us.

The Vice-Chancellor of the University of Cambridge (Dr. Chase) said:—

The council of the Senate of the University of Cambridge is deeply conscious, as, indeed, everyone must be who looks thoughtfully on the events of the time, how much that higher culture and that thorough scientific study and research which it is the province of a university to promote are needed for the service of the English nation.

It appears to us that the universities, in view of the increasing work which they are doing on behalf of the nation, are justified in asking for the sympathy and the cooperation of the State. We heartily join in the prayer that the Government would be pleased to regard the work of universities as of supreme national and imperial importance, and to give such aid as the several universities need and as wider considerations of national finance render possible.

Mr. Chamberlain, as Chancellor of the University of Birmingham, speaking on behalf of the new universities, said:—

Let me take Birmingham as an example and as a parallel to what is being done in Liverpool, Manchester, Wales, and Leeds. We have had to prepare the plan of a new scientific university, to deal only with that side of our work, at an estimated cost of 1,000,000*l.* sterling. Even then we shall not have fulfilled all our objects, for there will be many branches of higher scientific and practical education for which we have made no sufficient provision. In the case of Birmingham local subscription has produced about 450,000*l.*, and on the basis of that subscription we have put in hand what will amount to little more than one-third of the university requirements. We have called in aid the local rates, and the three counties of which Birmingham is the centre each contribute the sum of 500*l.* a year, and the corporation of the City of Birmingham has offered in aid a rate of $\frac{1}{2}d.$ in the pound, which will produce something between 6000*l.* and 7000*l.* per annum. Now, whatever may have been done, it is not enough, and we recognise that by our own unassisted resources alone we cannot provide the kind of education we believe the country requires. Already the State pays something like 13,000,000*l.* a year for primary education. Only a few thousands a year are found for the higher education to which we have learned to attach so great a value. I am not speaking merely as a Chancellor, but I have had some practical experience of the advantage which every statesman finds in discovering sources from which funds may be provided for all the admirable objects brought to his notice, and I do not press on you any particular figure or method of dealing with the important matter we have brought before you, but I hope we may have some crumbs from your table. I hope at least the present Government may be able to make a satisfactory beginning in recognising these new necessities. Possibly that beginning may not be wholly satisfactory to us, but we shall be always ready to take half a loaf until the time comes when we can get the whole, and I believe the initiation of such a policy on the part of any Government will be one of its best claims to the gratitude of the people of this country.

Sir William White, K.C.B., F.R.S., speaking as president of the Institution of Civil Engineers, and

as a representative of all branches of engineering, said:—

During the past year a committee representing all branches of engineering, and nominated by all the principal engineering societies of the country, has been considering the best system of training for engineers. Its work is still incomplete, but its investigations make it obvious that great extensions of existing universities and university colleges which provide for engineering education are needed in order to meet national requirements and to secure equality of conditions with those existing in other countries where industrial enterprise is making great strides.

British engineers consider that private enterprise and generosity should continue to play a leading part in the support of institutions for teaching the higher branches of their profession, but they hold that, in view of what is being done abroad, it is absolutely necessary that private efforts should be supplemented by substantial Government aid. Such a course on the part of the Government would undoubtedly tend to stimulate private generosity, and before long would place this country in a position of relative efficiency greatly superior to that which now prevails. With the rapid development of engineering now taking place in all directions, there is an absolute necessity for scientific procedure and a thorough knowledge of principles on the part of those employed therein. Unless immediate steps are taken to remedy needs that are universally recognised, the industrial position of this country must become increasingly unsatisfactory.

The importance of the application of science was urged by Sir William Ramsay, K.C.B., who, in the course of his remarks, said:—

In asking for a new departure—the State endowment of universities—we must inquire what information we can obtain from others who have previously made experiments. We find that on the Continent successful experiments have been made for many years. In these practical researches Germany has taken the lead; but in all European countries, and in America, progress is being made on lines closely resembling those which have been found advantageous in Germany. We may note that almost all the proprietors of chemical works, or of works which depend for their success on the application of chemical principles, are either university men who have taken a degree in science or men from "Polytechnika," who have taken a diploma.

One reason for the almost universal spread of university education is the very small fees that are charged to students. By far the larger portion of the cost of university education is paid by the State—probably three-quarters. Ten pounds covers a year's education in fees, whereas forty pounds must be charged here in non-endowed universities.

This close contact between science and industry can be maintained only by a graduated and relatively high scale of pay for the professors in the large universities. Unless the prizes are sufficient to tempt men to choose a scholastic career instead of a commercial one, the ablest young men will choose commerce.

In America most of the chemists have either been educated in Germany—the older generation especially—or have been trained in copies of the German schools of chemistry. Hence America entertains much the same ideas as Germany as regards the importance of scientific training. Indeed, manufacturers engage the services of youths who have not finished their "college" career.

As regards the merits of universities and "Polytechnika," the main difference is that in the former students have been trained in methods of research, whereas in the latter they have been taught what is already known. I am informed by a leading German manufacturer that he prefers the university youths to those trained in "Polytechnika," because the former are more suggestive. The inventive power is recognised as the highest and most lucrative when applied to industry. I am convinced that the bestowing of money on the support of the university teaching of science, while desirable for its own sake, will be like casting bread upon the waters, it will be repaid a hundred-fold.

In referring to the needs of the younger universities in respect to literary studies, Sir Richard Jebb, M.P., remarked:—

It would be a serious national misfortune if our education should become one-sided. The humane studies—history, philosophy, language, literature—cultivate the imagination, enlarge the sympathies, widen the outlook upon life, aid in fitting people to understand one another and to cooperate intelligently; in a word, they are essential elements in the formation of the efficient worker, whatever his line of work may be. That cardinal fact is thoroughly well understood in those countries where education, from the lowest to the highest grade, is best organised. Let us see to it that in our own country we do not overlook this fact. The men of science go heartily, I believe, with the men of letters in desiring that it should not be overlooked. The importance of maintaining such an equipoise in education might be urged on the utilitarian ground, as a condition of our holding our own in the competitions of the civilised world. But it must be urged also on a higher ground, as a thing essential to the intellectual and spiritual well-being of the nation and of the Empire.

Sir Henry Roscoe pointed out the influence of scientific research on our national well-being; and in his speech he said:—

It is to the university that we must mainly look to raise the type of man who by training and character is fitted to prosecute research. Are our British universities at the present moment adequately equipped in men and material to enable them to carry out successfully this national work? A comparison of their capabilities with those of other countries shows a deplorable deficiency in both the above respects.

This state of things being generally admitted, we come before you as the head of the Government to ask you to bring about that closer connection between scientific method, scientific studies, and national industry, upon which you have so strongly insisted, by giving to our universities a State endowment which will not merely serve as a national insurance against attack from without, but is, unlike others, a productive insurance which will repay the nation, not merely once, but over and over again.

Speaking more especially as a business man who has noted the effect of applied science in the industrial world, Mr. A. Moseley, C.B., remarked:—

I am practically impressed with the necessity for those in training for commerce and industry to be thoroughly equipped with technical instruction of university rank, designed to bear especially upon the particular vocations that the rising generation intend entering. On the points mentioned we are distinctly behind both Germany and the United States of America. The success of the United States at present, and perhaps even more so in the future, is and will be due to the higher scientific and practical training her young people receive in her universities first and technical colleges afterwards.

Mr. Bell, M.P., speaking in the absence of Mr. Burt as the representative of artisan classes of the country, said:—

This question is one of vital importance. Unfortunately, my practical knowledge of universities is little. But hitherto a university training has been the luxury of the comparatively well-to-do. The aim is to open the door to the choicer spirits of the poorer classes.

Lord Kelvin wrote to the president of the British Association expressing his regret at not being able to be present and his hearty wishes for the success of "every effort for the much-needed improvement and strengthening of the universities of the United Kingdom."

In the course of his reply to the deputation, Mr. Balfour said:—

I do not suppose that there have ever before been congregated in one chamber so many representatives of learning in this country. We have been told that we have fallen far behind at least two great countries in our educational

facilities. But I do absolutely deny that there is the smallest sign that in the production of these germinating ideas of science we have shown any inferiority, either to our relations across the Atlantic or to Germany, which I may remind the assembly has for many generations pursued this State-endowing process of applying science to industry. That we are behind Germany in that way I do not deny. Germany had a technical university, or gave technical teaching, I think, as far back—I am refreshing my memory—as the end of the eighteenth century, if not before. Of course, the general system of thought in Germany, the habits of the people and the Government in this respect places them at a great advantage as compared with us as far as the endowment of universities can help a nation, as I doubt not it can, in the industrial struggle. But my point is that mere endowment of universities will not, I think, add greatly to the output of original work of the first quality. What, then, will it do? It will do, or may help to do, what is, perhaps, now more important. It will provide an education which will render fit for industrial work all persons who, without university education, would be very ill equipped indeed. I concur with all the speakers to-day that there is a great need—a great financial need—both in the new and the old universities for help towards this object. But I would beg to point out that there is even a greater necessity than a well equipped university—that is, that capitalists should be prepared to realise what we realise in this room—the necessity of giving employment to those whom these universities are to turn out. I was much struck by an observation of Sir William White's. He pointed out that we possess most of the ships of the world—that we are the largest shipbuilders in the world—and yet he said that Germany has an incomparably larger number of students, far better machinery for educating these students, and more men occupied in the shipbuilding yards; and what Germany has done the United States are doing. One of two things is clear. Either our shipbuilders think this qualified class is necessary or they do not think so; or else they find British students, even though turned out in smaller quantities, are sufficient for their purpose, or they employ American and German students for their works. Are our manufacturers convinced that they get a better man if they get one who has been to a university? Or do they think that if a young fellow wants to become one of the captains of industry he should begin early in life? I think there is some evidence to show that they prefer the older course; and I should suggest they are wrong; and if they are wrong you must convince them they are wrong, otherwise there will be no advantage in turning out qualified students, for they will be content to use the man who acquires his training by actual day-to-day labour on the ship, but is not qualified by these higher scientific attainments which are more and more becoming necessary.

One other thing we want, and that, I think, is the creation of positions which will enable a man who has exceptional gifts of originality in science to devote his life to the subjects of his predilectinn so as not to be driven to another kind of life in which he will not be able to render the full service of which he is capable to his country. In Germany certainly—I am not sure about the United States—such positions exist to a far greater extent than in this country. In the main they must be attached to the universities. I cannot conceive any more admirable use of any funds which the universities can command than the increase of the number of such positions.

In the course of his remarks, the Chancellor of the Exchequer said:—

It would be of some assistance to those who may have to decide in future when money is available if the universities would consider to what extent they are willing to come under control if they receive grants, to what extent the State is to have a voice in fixing the fees of the students, to what extent it is to direct or influence the teaching, whether it is to allocate its assistance to promote special branches of study, or whether it is desired to make every university complete in itself. Some further exposition of their views would make it easier to deal with this question when the time comes for dealing with it.

THE MEETING-PLACE OF EAST AND WEST.[1]

THE publication of Dr. Stein's preliminary report to the Royal Geographical Society and of his own personal narrative of his explorations among the "sand-buried ruins of Khotan" is one of the most important archæological events of the year 1903. For the full scientific publication of the whole of his discoveries by the Indian Government we must perforce wait awhile, but we have all that is needed to enable us to form a general idea of them in the interesting and well published volume which lies before us.

Chinese Turkestan hardly sounds as if it were a land of very great interest, yet, as a matter of fact, it is historically one of the most interesting countries in the world. It is not a comfortable country: merely a string of oases half overwhelmed by a devouring desert of shifting sands, the great Taklamakan, and barred off from the rest of the world by huge and impassable mountains, scorchingly hot in summer and frozen by Arctic cold in winter. Yet these remote wilds have seen one of the most interesting phenomena of history, the meeting together of the civilisations of China, of India, and of Europe; here the antique culture of China had in the early days of the Roman Empire already been brought into contact with Græco-Roman civilisation, and we see the result of the meeting of the two, or, including India, three streams of civilisation in the mixed culture of Turkestan in the early centuries of the Christian era, which Dr. Stein has brought to light.

In those days Chinese Turkestan was the bridge between west and east; from west to east journeyed Roman merchants to buy the precious silk of Serica, and Persian ambassadors or fugitive princes passed seeking the assistance of the mighty Emperor of China; from east to west Chinese armies marched through Turkestan into the basins of the Oxus and Jaxartes, and even reached the Caspian, and Chinese pilgrims, like Fa-hien and Hiuen-Thsang, passed the fanes of Khotan on their way to the holy places of Buddhism in India; traffic to and fro was continuous, and the oases of the Taklamakan could maintain many famous cities, rich temples, and monasteries of renown.

In those days of her importance, as still in these of her desolation, eastern Turkestan was under the political hegemony of China. Legends, indeed, ascribe a remote date B.C. to the first entry of the Chinese into Kashgaria, but since real history (as apart from annals which have not yet been critically sifted) can hardly be said to begin for China before the reign of the great reformer Tsin Chi-Hwangti (B.C. 250), "the burner of the books," we are probably right in assigning the first Chinese occupation to the early days of the Han dynasty, under the emperor Han Wu-ti (B.C. 100), and its first real conquest to the famous General Panchao, who is said to have carried the Chinese arms as far west as the Caspian, and to have attempted to open up direct relations with the Romans (about A.D. 100). Henceforward Kashgaria remained nominally tributary to China; but though individual emperors asserted their authority in the far west from time to time, the country does not seem to have been regularly organised as a Chinese possession until the reign of the great Emperor Tai-tsong, the first monarch of the T'ang (A.D. 634). Under his equally powerful son Kao-tsong we find Chinese viceroys installed in Turkestan, who entered into regular relations with the peoples of the west. The last Sassanian King of Persia, Yazdijird, communicated with them, demanding Chinese assistance against the conquering warriors

[1] "Sand-buried Ruins of Khotan; Personal Narrative of a Journey of Archæological and Geographical Exploration in Chinese Turkestan." By M. Aurel Stein. Pp. x+503. (London: Hurst and Blackett Ltd., 1904.) Price 7s. 6d. net.

of Islâm, who were now overrunning his kingdom, but Kao-tsong refused to attack the Arabs. Firuz, a son of Yazdijird, fled to the Chinese court at Si-ngan-fu, and Kao-tsong proclaimed him King of Persia after the murder of Yazdijird. He was, however, never able to enter into possession of his kingdom, the Arab conquerors of which sent a formal embassy to the Chinese Emperor four years later (A.D. 655).

Thus Chinese Turkestan served as a bridge between east and west in the days of the great T'ang.

Since the period of the T'ang, Kashgaria has always remained nominally subject to China, and, despite the victory of the western religion of Muhammad over Buddhism, Chinese civilisation has always retained it in its *Kulturkreis*; the Chinese authority has always stood for order and for civilisation, and whenever, as in the years of independence under Yakûb Beg during the 'seventies of the nineteenth century, Islâm has succeeded in ousting the infidel rulers of the land, utter anarchy and barbarism has resulted. The defeat of the Muhammedans by the Chinese general Liu Kin-tang in 1878 was a victory for civilisation. To-day Chinese authority is more in evidence in Kashgaria and more firmly upheld than at any time since the days of the T'ang. The whole story of the retention of Kashgaria, not merely as an outpost of Chinese civilisation, but actually as a Chinese possession, throughout history, is an interesting testimony to the real civilised energy and organising power of the Chinese, as well as to their dogged persistence in pursuing their ends.

Chinese Turkestan is, then, a land of remarkable historical interest. Further, it is, like Egypt, a land in which archæological excavation would be likely to reap rich harvests, for here, as in Egypt, we have two factors which are of inestimable service in preserving the relics of the past intact—dryness and desert sand. The sand covers and protects, the dryness preserves. Hence it is that systematic excavations in the Egyptian manner, now for the first time essayed in Turkestan, have yielded such important results to Dr. Stein. Sven Hedin had already reported the existence of ancient remains in the Taklamakan, and Dr. Stein has explored and excavated them, bringing back with him an invaluable collection of relics of the early civilisation of this strange land, the bridge between west and east. His finds belong mainly to two distinctly marked periods, the third and eighth centuries A.D. The most important of the earlier sites is that in the desert north of Niya, away to the east of Khotan. Here was excavated a regular town of wooden buildings half buried in the sand, with the remains of the trees of its ancient orchards still standing around it. The date of the settlement is given by a document of the reign of the Emperor Tsin Wu-ti, of the Later Tsin (A.D. 265–290). Among the inhabitants Chinese officials were probably included, but the majority seems to have been of Indian origin. This is shown by the discovery of numbers of wooden tablets and parchments inscribed with Indian Kharoshthi writing. These are chiefly reports to the Indian rajas who governed the country. From this we see that the tradition of an Indian conquest of Kashgaria in remote days is founded on fact. That this Indian kingdom formed a road by which the culture of the west penetrated to the east there is no doubt. At Niya, indeed, has been found a striking confirmation of this; five hundred years after Alexander, we find in Turkestan an Indian letter sealed with a Chinese and with a Greek seal side by side! Greek intagli were in common request in this remote Chinese dependency, and the influence of the art of Gandhâra on that of Khotan is very evident from the numerous small objects collected by Dr. Stein on the site of Yotkan, the ancient representative of Khotan-town. The question as to how far Chinese art is really indebted, through the medium of Khotan and Gandhâra, to that of Greece has, apparently, yet to be worked out.

The other excavated sites are later in date. The miscellaneous antiquities from Yotkan partly bridge over the gap between the period of Niya and the period of Dandan-Uiliq, the most important of the later sites; and the great Rawak Stupa in the Yurung-kash district, which has yielded to Dr. Stein material of the most important kind for the history of early Buddhist art, belongs to the intermediate period. Ranged along the base of this *stupa* is a series of colossal stucco figures in alto-rilievo, representing Buddhas or Bodhisattvas (Fig. 1), and attendant Arhats, these last sometimes represented as grouped in the halo of a great Buddha. These remarkable examples of Buddhist art were mostly too bulky and delicate to be removed, and so were re-buried by the explorer after a complete series of photographs had been taken of them. Many of these are published as illustrations to chapter xxx. of Dr. Stein's book.

FIG. 1.—Rilievo Statue of Bodhisattva on South-west Wall, Rawak Stup Court. From "Sand-buried Ruins of Khotan."

Dandan-Uiliq is a site outwardly much resembling Niya, which Dr. Stein afterwards excavated, and has yielded, like Niya, many written records, but of course of later date and written in different languages and scripts. In some cases these are still of Indian origin. When the script is Brahmi, the language is sometimes Sanskrit, sometimes an unknown tongue, no doubt the native Indo-Scythic of Turkestan, the language of the *Yue-tchi*. The writing is usually upon paper, less usually on wood. The contents of the Brahmi documents are religious. Civil records, analogous to the Kharoshthi tablets of Niya, are chiefly Chinese. The settlement was, in fact, a Chinese Buddhist monastery,

and its ancient name was Hu-kwo. The Chinese documents date to the end of the eighth century, long after the Indian kingdom was extinct, and when the Chinese dominion, which had been triumphantly re-asserted by T'ang Tai-tsong, was seriously threatened by the inroads of the "Ta-Fan" or Tibetans. Actual Tibetan relics were discovered at Dandan-Uiliq.

Larger antiquities were also discovered here, chiefly Buddhist reliefs of stucco, and, more interesting still, frescoes which give us an unlooked-for insight into the art of Khotan at this period. Exhibited in the Chinese section of the British Museum is a remarkable fresco from Dandan-Uiliq, one of the most important of Dr. Stein's discoveries, representing two equestrian figures, with their costume most carefully depicted. This is not illustrated in Dr. Stein's book, and the omission is to be regretted, as the picture is one eminently calculated to interest the general reader for whose use the "Sand-buried Ruins of Khotan" is chiefly intended.

Another site, beyond Niya, at Endere, has yielded remains of the same date as those from Dandan-Uiliq. This place, Endere, is the most easterly point which Dr. Stein reached in his explorations. It is distant from Khotan some 250 miles, and from Kashgar no less than 550 miles. This fact alone gives some idea of the extent of ground which Dr. Stein covered in his rapid journeyings. His explorations were indeed carried out with remarkable energy, and their great success is the fitting reward of this energy and pluck. For it must be remembered that much of Dr. Stein's work was carried out in the intense cold of a Kashgarian winter, when the thermometer often fell to below zero Fahrenheit in the explorer's tent, when it was hardly possible to hold a pen for the cold, and even sleep was sometimes banished by its intensity. Under these extreme conditions Dandan-Uiliq and Niya were excavated. If we add to these rigours the difficulties of the journey from India over the Pamir passes, we gain some idea of what Dr. Stein has done. His mission has succeeded beyond his own most sanguine expectations, and the Indian Government has indeed served the cause of science well in sending him to Turkestan.

FIG. 2. Eroded Ranges of the Kuen-lun, seen from above Yagan-Dawan. From "Sand-buried Ruins of Khotan."

Incidentally Dr. Stein carried out very important surveys of the Kuen-Lun range (Fig. 2), and connected his own surveys with the trigonometrical survey of India, thus definitely fixing the exact geographical position of Khotan. Also he was enabled to do a great service to archæology by detecting and exposing the remarkable forgeries of ancient documents in "unknown scripts," the work of a clever rascal named Islam Akhun and a few confederates, which had been sold to travellers as genuine antiques, and had long mystified the learned into whose hands they had come. It was the appearance in India of these forgeries (together with a few genuine relics from Dandan-Uiliq, which had given the forger the idea of his deception) which first impelled Dr. Stein to the systematic exploration of the ruined "cities" from which they were said to have come. He has now cleared up the mystery: we now know what is genuine in the way of written documents from Turkestan and what is not. But, above all, Dr. Stein has discovered really new archæological material in the Kharoshthi tablets from Niya and in the Brahmi documents in a non-Indian tongue from Dandan-Uiliq. To students of Buddhism the relics of religious art from Dandan-Uiliq, the Rawak Stupa, and Yotkan will provide material for very important work.

H. R. HALL.

BRITISH ASSOCIATION MEETING AT CAMBRIDGE.

IN a former article (NATURE, April 21), a preliminary forecast was given of the local arrangements for the meeting of the British Association, to be held at Cambridge from August 17 to 24. The programme is now in an advanced state of preparation, and copies may be obtained after July 25 on application to the local secretaries at Cambridge. It may be of interest to give a short account of the arrangements in amplification of the incomplete summary already published.

It is expected that meetings of a sub-committee appointed by the International Meteorological Committee at Southport in September, 1903, to combine and discuss meteorological observations from the point of view of their relations with solar physics, will be held at Cambridge during the session of the association. The committee consists of twenty-two members, of whom eighteen represent the observatories or meteorological institutions of the Continent and America. The primary object of the meeting in Cambridge will be to constitute the organisation of the committee, and prepare a scheme of operations. The members of the committee will take part in the proceedings of Section A, particularly the subsection which deals with cosmical physics, under the presidency of Sir John Eliot, F.R.S.

The conference of delegates of corresponding societies will meet on Thursday, August 18, and Tuesday, August 23, at 3 p.m., in the large lecture-room, Gonville and Caius College.

Mr. Balfour will assume the presidency, and deliver an address in the Corn Exchange on August 17, at 8.30 p.m. A plan of the Corn Exchange may be seen in the reception room, and reserved seats secured up to 6 p.m. on Wednesday, August 17. For the con-

venience of visitors, a small number only of the seats will be allotted on Monday afternoon, and a considerable number of places in all parts of the building will be held in reserve for those who arrive on Wednesday, August 17.

At 3 p.m. on Thursday, August 18, the High Sheriff of Cambridgeshire will entertain the association at a garden party in the grounds of Emmanuel College, and at 5.30 p.m. the Registrary of the university will deliver a lecture at the theatre on the growth and origin of the university. At 9 p.m. there will be a reception of the association by the local committee in Trinity College.

On Friday afternoon, August 19, the mistress and resident staff of Girton College will entertain 500 members of the association at a garden party, and in the evening Prof. George Darwin will deliver a lecture in the theatre on ripple-marks and sand-dunes.

Saturday, August 20, will be devoted to excursions to places of interest in East Anglia. The local committee hopes that prominent members of the association will, so far as possible, take part in the excursions, which promise to be of considerable interest. A set of excursion guides and a map, which has been specially prepared by the Director-General of the Ordnance Survey, will be given to each member of the association.

The following is a list of the excursions:—

Audley End and Saffron Walden.—Audley End House will be visited by permission of the Lord Howard de Walden; the church and museum in Saffron Walden form other items in the programme.

Brandon and Didlington Hall.—The most attractive features of this excursion will be the flint knapping industry at Brandon, Lord Amherst's Egyptian collections, rare books and illuminated MSS. at Didlington Hall.

Cromer.—Mr. Clement Reid, F.R.S., has arranged an attractive itinerary for those interested in the geology of the Norfolk coast.

Dykes of Cambridge.—This excursion includes an inspection of the well-known Fleam Dyke and Devil's Ditch, under the guidance of Prof. Ridgeway; opportunity will also be afforded for botanising on the dykes. By the invitation of Mr. Richard Marsh, trainer to H.M. the King, tea will be provided at Egerton House, Newmarket.

Ely.—A visit to the cathedral, a building of exceptional architectural interest, under the guidance of the Dean, forms the most important feature of this excursion.

Wicken Fen and Upware.—Members will travel from Cambridge to Upware in steam launches. This excursion is likely to be of considerable interest to geologists, entomologists, and botanists.

Hatfield and St. Albans.—A visit to Hatfield House, by permission of the Marquis of Salisbury, visits to St. Albans Abbey, the site of Verulam, the sites of the battlefields of St. Albans, and the orchid houses of Messrs. Sanders, form the chief attractions.

Lincoln.—The exceptional architectural and archæological features of Lincoln seemed to the committee sufficient justification for arranging an excursion to this city, in spite of its distance from Cambridge. The Mayor of Lincoln invites members to tea in the Castle grounds.

Norwich.—The cathedral, the hospital of St. Giles, and St. Andrew's Hall are the most important buildings to be visited. Hospitality is offered by the Mayor of Norwich, and by Mr. and Mrs. James Stuart.

Sandringham, Lynn, and Castle Rising.—This excursion, which is likely to prove one of the most popular, includes visits to the Lynn churches, the castle and church at Castle Rising, also the grounds, kennels, stables, and dairy at Sandringham. Tea will be provided by invitation of H.M. the King.

Wisbech.—The Lord Lieutenant of Cambridgeshire has kindly invited members of the association to visit the old-world town of Wisbech, and facilities will also be afforded for inspecting the woad works.

The committee is greatly indebted to the authors the excursion guides for the full and interesting accounts which they have written of the places to be visited.

On Saturday the master and fellows of Peterhouse invite 600 members of the association to an evening party at 9 p.m.

On Sunday evening at 8.30 p.m., there will be a performance of unaccompanied sacred music by the combined choirs of King's, Trinity, and St. John's Colleges in the Chapel of King's College.

On Monday, August 22, the Lord Lieutenant of Cambridgeshire and the Mayor will entertain the association at a garden party in the Botanic Garden at 4 p.m. On Tuesday afternoon Mrs. Sidgwick, principal of Newnham College, invites 500 members to a garden party in the college grounds. The large room of the Cavendish Laboratory has been placed at the disposal of the committee for the exhibition of specimens. For information as to exhibits, application should be made to Mr. P. V. Bevan, the Cavendish Laboratory.

Arrangements have been made for members to have exceptional facilities for visiting the Botanic Garden, University Laboratory, the Observatory, the University Press, as well as college buildings and gardens. Cambridge schools and the Addenbrooke's Hospital may also be inspected at stated times, and visits have been arranged to several works in Cambridge, and to nursery gardens at Sawbridgeworth and Broxbourne.

In a subsequent article some account will be given of the sectional proceedings, together with a list of some of the colonial and foreign guests.

MODERN PRINTING PRESSES.

THE recent issue of M. A. Ducrot's "Presses modernes typographiques," published by the house of Gauthier-Villars, Paris (7 f. 50 c.), provides an opportunity for a short account of modern printing presses. The work is copiously illustrated, and describes, from a mechanical point of view, every kind of machine, from the small but handy platen to the awe-inspiring rotary, whilst the intermediate classes of cylinder machines are represented by many varieties, both of the single and double kind.

The only English work of a similar nature, devoted exclusively to machinery, is Wilson and Grey's "Modern Printing Machinery," published so far back as 1888, and therefore not up to date. This is to be deplored considering the great advance made in that department of the printing craft.

Although artistic printing was not altogether an unknown quantity during the nineteenth century, much progress was made in a general way during the latter part of that century, which also marked the introduction of machinery, but its general adoption was a matter of time. Through William Morris's work at the Kelmscott Press, much impetus was given to what may be termed the decorative side of printing, but the invention of the many processes of reproduction in connection with letterpress illustration, and the enormous development of such processes, have necessitated printing machinery of a different and much improved character in order to cope successfully with the demand for graphic literature.

That American engineers have in recent years taken the initiative in this direction will be admitted, but it is some consolation for English printers to observe that the home manufacturers are beginning to realise the situation, and are endeavouring to make amends and thus regain their position in the field.

In looking abroad it is customary to associate Messrs. Hoe's name with some of the best of American machinery, whilst for that of French origin the late M. H. Marinoni was looked upon as the best manufacturer of machinery especially adapted for newspaper or magazine work. To specify other names in either country would require space, although in fairness to Germany it must be said that many really good machines of various kinds are now before the trade and at work in this country.

To the lay reader it may be explained that the various classes of machinery used for letterpress printing are divided under certain heads, and may be broadly grouped as follows:—(1) rotary machines; (2) double cylinder perfecting machines; (3) single cylinder one-feeder machines; (4) single cylinder two-feeder machines; and (5) platen machines.

Commencing with the rotary kind, as its name implies, the action is that of continuous rotation whilst the machine is in motion. Although there are a few machines on the market with flat type beds that print from the reel, this class of machine generally prints from a surface made from either stereotype or electrotype plates, and curved to the cylinder similar to the one which gives the impression—the paper as it is unwound from the reel passing between the printing and impression cylinders continuously whilst the machine is running.

The paper is made to the required width and wound on reels; sometimes these webs contain paper two or three miles long, the length being regulated by the weight or thickness of the material. Such machines are used mostly for newspaper work, or magazines of a non-illustrated character, where a large number of copies are required, and each section or copy is cut and folded before it leaves the machine. They are also made in duplicate, quadruple, or even larger sizes, so that the machine is self-contained, and will produce just as many duplicate copies as it is constructed for.

It is true that illustrated work is now attempted on rotary machines, and whilst no doubt further improvements will be made in due course, the results are not altogether satisfactory so far, although illustrations in line are more successful than those produced by the half-tone process.

Perfecting machines have two cylinders, and are used mostly for newspaper or magazine work of shorter numbers, and occasionally for bookwork. These print both sides of the paper, which is in single sheets, before it leaves the machine, but the double impression is two distinct operations. Although this class of machine has been used for a great number of years, it is not adapted for the best class of bookwork owing to the difficulties of ink set-off. These machines, and all other than the rotary kind, print from a flat printing surface.

The single cylinder (one-feeder) is *par excellence* adapted for the best bookwork, whether illustrated or not. Of this class there is a great variety, the English make being called the "Wharfedale," and built on the stop-cylinder principle, that is, the cylinder over which the sheets of paper are carried, and which gives the impression to the printed sheet as it revolves, is stopped or locked on the return travel of the machine, when it is automatically released and revolves again as the type carriage or bed travels forward once more.

Other single cylinder machines are those of the two-revolution kind, that is, the cylinder revolves continuously in the same direction, once whilst the sheet is being impressed and again whilst the type bed is travelling back to its original position, thus making two revolutions for each copy printed. This class of machine is well represented by the Miehle and Century, both of which are of American manufacture, and are admirably adapted for high-class illustrated work of the magazine order because the inking facilities are so well considered.

Another kind of single cylinder machine is the two-feeder, and it may be described as being somewhat similar to the ordinary Wharfedale, but it has a longer travel for its type carriage, with an arrangement at both ends of the machine for inking and rolling the forme. Unlike the stop-cylinder of a single feeder machine, which is stationary on the return travel, the impression cylinder of the two-feeder immediately reverses on the completion of the revolution on the principle of the old "tumbler" machine. In doing this a fresh sheet is seized by a second set of grippers or fingers attached to the cylinder. By this method a sheet is printed at each propulsion of the machine in either direction.

Those of the platen kind are used for smaller work, mostly of a commercial character, and the action is somewhat similar to that of the old hand press, because both type and paper are impressed on the flat. They are made in many sizes, and some will print almost as large a sheet as the old hand press. Although one operator only is required, he will, with the aid of power, produce at least three or four times as much as two men at hand press with equally good results, provided the worker is a skilled hand.

CHAS. T. JACOBI.

CANCER RESEARCH.

As Dr. Bashford remarks in his introductory note to the report of the Cancer Research Fund,[1] the solution of the problem of the cause of malignant disease in man is really the logical destination and centre towards which all channels of cancer research must converge, rather than the starting point thereof. The zoological distribution of cancer has therefore formed one of the first lines of inquiry to be undertaken by the Cancer Research Fund, founded about two years ago, for investigating this dire disease. By the willing cooperation of many workers, a most interesting series of tumours has been obtained from the various domestic animals, from the mouse and hen, and from three species of fish, proving that malignant disease is not confined to man. The malignant growths of man seem to be incapable of transmission to animals, but a malignant new growth from one animal may occasionally be transmitted to another individual of the same species. This has been carried out by Jensen, of Copenhagen, and by Borrel, of Paris. Through the kind collaboration of Prof. Jensen, a specimen of epitheliomatous tumour of the mouse was obtained and successfully transplanted into mice, but not into other animals, thus confirming Jensen's results.

The last half of the report contains an account of Dr. Bashford and Mr. Murray's investigations on the cytology of malignant growths, illustrated with a number of drawings. The results obtained are practically the same as those of Prof. Farmer, Mr. Moore, and Mr. Walker, already detailed in these columns (NATURE, vol. lxix. p. 319), viz. that in the cancer process there is a transformation of the normal

[1] "Scientific Reports on the Investigations of the Cancer Research Fund. No. 1. The Zoological Distribution, the Limitations in the Transmissibility, and the Comparative Histological and Cytological Characters of Malignant New Growths." (Taylor and Francis, 1904.)

adult tissues into modified reproductive or "gametoid" tissue. This, however, does not completely explain malignancy; there may possibly be in addition conjugation of cells or of nuclei. Let us hope that before long Dr. Bashford and his colleagues may give us further information on these and other points so necessary for the complete solution of the cancer problem.

The reports of the cancer research laboratories of the Middlesex Hospital [1] contain several papers which are, however, for the most part of purely medical interest, *e.g.* cancer in certain organs, and various methods of treating the disease. A report by Prof. Karl Pearson on cancer statistics collected by Messrs. Hillier and Tritsch is of considerable interest. For this the histories of 3000 cases of cancer were carefully analysed, and the results of Prof. Pearson's mathematical analysis are:—(1) as regards age incidence frequencies, that cancer is far more likely to occur in childhood in the male than in the female; (2) as regards a family history of cancer (that is, heredity in cancer), there seems to be a slight correlation between a case of cancer and a family history of cancer, but this is so slight as to be within the probable error of random sampling; and (3) that there is little or no relation between the presence of cancer and a tubercular family history, but there is a relation between the presence of cancer and the presence of tuberculosis.

The first report of the Liverpool Cancer Research Fund [2] has also recently been issued. This fund has been instituted by Mr. Sutton Timmis, who has vested in two trustees a sum of 10,000*l.*, which is administered by a committee empowered to spend 1000*l.* to 1500*l.* per annum until the fund is exhausted or the cause of cancer discovered. A cytolytic milk has been prepared by injecting a cow with carcinomatous material, but the cases treated with it are not yet sufficiently numerous to allow an expression of opinion as to its value. Investigations are also being made into malignant growths of man and animals by Dr. Albert Grünbaum, who has been appointed director of these researches.

Mr. Cecil H. Leaf in a booklet [3] discusses the clinical causes and prevention of cancer of the breast, with an analysis of 100 cases. Of the 100 cases, 84 were married and 16 single, and the author thinks that very early marriages and errors in lactation may act as exciting causes. In 35 of the cases there was a definite history of injury, and unsuitable corsets are suggested as taking some share in the production of mammary cancer. Diet, *e.g.* excessive meat eating, use of alcohol, and of salt, could not, as has been suggested by some, be ascribed as a cause of the disease. Finally, some suggestions are made with the view of prevention.

R. T. HEWLETT.

ELECTRICAL TRANSMISSION OF PICTURES AND SCRIPT.[4]

THE problem of distant electrical vision is one to which much speculation and experimenting have been devoted. Before this problem can be attempted with any hope of success, however, the preliminary one of the electrical transmission of photographs over a distance has to be solved. This problem, it may be stated at once, has been mastered, and it is now possible to transmit photographs in this manner, and successful results have been obtained over telegraph and telephone lines 800 kilometres long.

It does not need much consideration to see how important such a process would be for journalistic and police work if it could be industrially exploited, and it were possible simply to hand a sketch or photograph in at the telegraph office and send the same as one now sends an ordinary telegram. The evening papers would be able then to publish photographs taken at the seat of war in Korea on the same day. Unfortunately, with the apparatus at present to be had, the time taken to transmit a half-plate photograph is half an hour. The cost of the use of a telegraph line of any length for half an hour would be, it is needless to point out, prohibitive. The lessening of the required time of transmission is, however, simply a matter of further development, and no good reason can be seen why in a few years' time the process should not be an adjunct to every existing telegraph line.

The author of the present work has devoted considerable time to this subject, and his booklet consists of an exact description of the apparatus and processes he has worked out. The author is to be commended on the very precise and careful way in which he has described every detail, so that it would be possible for anybody, with the help of this book, to reproduce, without any original work, the same results as he has obtained himself.

The method shortly consists of the following:—A ray of light is made to pass systematically all over the transparent film to be transmitted. After passing through the film it impinges upon a selenium cell the resistance of which varies proportionally to the amount of light which passes through the photograph. These varying currents pass through the line and are received in a moving coil galvanometer the pointer of which, in moving, inserts or takes out resistance in a high tension circuit, according as the current flowing in the moving coil changes. In the high tension circuit a small vacuum tube is connected, and it follows that the illumination of this tube is proportional to the light passing through the plate at the transmitting end of the line. This vacuum tube now passes over the sensitised photographic paper in synchronism with the ray of light over the transmitted plate, and thus a reproduction of the same is obtained. The transmitted film and sensitised paper are each wrapped on a glass cylinder. These cylinders are rotated by motors, and synchronised once each revolution. Only one wire is needed for the transmission, with, of course, an earth return.

In the case of the transmission of handwriting and half-tone illustrations, the same are got up on metal foil with electrically non-conducting ink. A conducting point then travels over the metallic foil, and closes and opens the sending circuit according as it is travelling on a marked or an unmarked place. The receiver used by the author is a modification of that described above, the essential point being the use of the vacuum tube fed with the Tesla currents. The speed reached is 500 written words per hour. For a half-tone illustration a strip ½ cm. wide and 10 cm. long can be sent in 100 seconds.

It would seem that there is not very much practical value in the transmission of handwriting; the type printing telegraph of to-day fulfils all ordinary requirements, and it would be only very seldom that a transmission of handwriting would be required. It is to be hoped, however, that this electrical "distant photography" will make rapid progress.

C. C. G.

[1] "Archives of the Middlesex Hospital. Vol ii. Second Report from the Cancer Research Laboratories." Edited by Alex. G. R. Foulerton, F.R.C.S. (Macmillan and Co., Ltd., 1904.)

[2] "First Annual Report of the Liverpool Cancer Research (The Mrs. Sutton Timmis Memorial Fund), Albert S. Grünbaum, M.D., Director." (University Press of Liverpool, 1904.)

[3] "The Clinical Causes of Cancer of the Breast and its Prevention." By Cecil H. Leaf, M.A., M.B., F.R.C.S., Assistant Surgeon to the Cancer Hospital. Pp. 64. (Archibald Constable and Co., 1904.) Price 2*s.* net.

[4] "Elektrische Fernphotographie und Aehnliches." By Dr. Arthur Korn. Pp. 66. (Leipzig: S. Hirzel, 1904.) Price 1 mark.

NOTES.

We deeply regret to see the announcement that Dr. Isaac Roberts, F.R.S., died at Crowborough on Sunday last.

The monument erected in the Place Breteuil, Paris, to the memory of Pasteur, was unveiled on July 16 by President Loubet. The ceremony was attended by the members of the diplomatic body, by prominent men of science, and by representative Government officials. Speeches eulogising the services rendered to science by Pasteur were delivered by the French Minister of Public Instruction, the Prefect of the Seine, and the president of the Paris Municipal Council. Prof. Herrera, of the University of Brussels, spoke in the name of the foreign subscribers. The monument is the work of M. Falguière.

The Postmaster-General introduced into the House of Commons on Monday a Bill for the regulation of wireless telegraphy. The Bill makes no attempt to create a State monopoly in wireless telegraphy, but merely aims at regulating its use in the country in a way that shall prevent the undue clashing of conflicting interests. The Government has at present no jurisdiction over telegraphy unless both ends of the system are within the United Kingdom or within the three-mile maritime limit. It is proposed to deal with the matter by means of licences. It is obvious that the peculiar conditions under which wireless telegraphy is worked, particularly the fact that neighbouring installations cannot at present be operated without interfering with one another, make it very desirable that the Government should be able to exercise a certain amount of authority in such questions, for example, as the selection of sites for transmitting stations. The great strategical value of wireless telegraphy to the Navy makes the matter of still more importance.

In connection with wireless telegraphy, we note that Mr. Duddell has recently been carrying out some experiments for the Post Office in Bushey Park with the new thermo-galvanometer which he exhibited at the recent Royal Society soiree. This instrument is capable of directly measuring the current received by the aërial at the receiving station, and thus affords a means of making scientific experiments on many of the problems connected with the subject which have long waited for a satisfactory elucidation.

The weather report issued by the Meteorological Office for the week ending July 16 shows that from the beginning of the year the rainfall has equalled or exceeded the mean in all districts except the north-east and east of England and the midland counties, where it is still an inch below the average. In the north of Scotland the fall is $4\frac{1}{2}$ inches above the mean. The temperature for the week was above the mean in all districts, amounting to 6° in the midland counties, where the maxima reached 85°. The same value was recorded in south and east England. On Sunday last the maxima were still higher, reaching 91° in parts of Hertfordshire. Thunderstorms have occurred in many places.

The Bombay branch of the Royal Asiatic Society will celebrate its centenary on January 17, 1905.

The International Botanical Congress will meet in Vienna in 1905 from June 12 to June 18.

The deaths are announced of Prof. Albert Rilliet, of Geneva; of Prof. V. Merz, formerly of Zürich; and of Prof. Karl Bopp, formerly of Stuttgart.

The death is announced of Prof. F. Knapp at the age of ninety-one. Prof. Knapp was for many years professor of applied chemistry in the Chemical Institute at Brunswick. He was a former student and son-in-law of Liebig.

Signor Pietro Blaserna has been elected president and Signor Francesco d'Ovidio vice-president of the Reale Accademia dei Lincei, of Rome; Prof. Giuseppe Gabrielli has been appointed librarian.

Dr. E. Rupp, of Marburg, and Dr. F. Dolezalek, of Berlin, have been raised to the rank of professors; Prof. F. Schilling, of Göttingen, has been appointed at the technical school of Danzig, and Prof. von Margold, of Aachen, has also been appointed there, both as professors of mathematics.

The specimens and other material collected by the Scottish Antarctic Expedition have arrived at the headquarters of the expedition in Edinburgh. The *Scotia*, with the members of the expedition on board, is expected to reach the Clyde to-day.

Provisional arrangements have been made by the American Society of Civil Engineers and the Canadian Society of Civil Engineers for the forthcoming visit of members of the Institution of Civil Engineers to the United States and Canada. Broadly, the visit will commence with a week spent in New York and the neighbourhood. Thence, a journey will be made to Montreal by a special train placed at the disposal of the party. A week will be spent in Canada, for which similar special travelling facilities will be provided; and this part of the tour will be concluded at Chicago, whence the party will proceed (again by special train) to St. Louis, which is expected to be reached on September 30. The party will leave Liverpool by the Cunard ss. *Etruria* on September 3, and may expect to reach New York on September 10.

The following is an abridged summary of the prizes offered by the Belgian Academy for 1904 and 1905:—For 1904, in mathematics and physics, critical phenomena in physics, viscosity of liquids, study of n-linear forms where $n>3$, thermal conductivity of liquids and solutions, each a prize of 600 francs; unipolar induction of Weber, 800 francs. In natural sciences, the Cambrian rocks of Stavelot (Belgium), 800 francs; modifications produced in minerals by pressure, 600 francs; development of Amphioxus (see *Bulletin*, 1904, No. 4, for corrected announcement), 1000 francs; effects of osmotic pressure in animal life, and Devonian flora of Belgium, each 600 francs; heterœcism of parasitic fungi, 800 francs; and physiological action of histones, 1000 francs. All memoirs to be written in French or Flemish, and sent in before August 1, 1904. For 1905, in mathematics and physics, combinations of halogens, 1000 francs; physical phenomena accompanying mutual dissociation of liquids, 800 francs; linear complexes of the third order, 600 francs; principal terms in the periodic deviations of the vertical, 600 francs. In natural science for the same year, effect of albuminoids in nutrition, reproduction of Dicyemidæ, formations intermediate between the Bruxellian and Tongrian in Brabant, geological age of certain Oligocene deposits in Belgium, sexuality of the individuals resulting from division of a single ovum in certain diœcious plants; prizes, 1000 francs for each of these five subjects; silicates of Belgian rocks, &c., 800 francs. In addition to these ordinary prizes the academy will award the following:—June 30, 1905, a Charles Lemaire prize relating to public works; June 30, 1904, a Louis Melsens prize for applied chemistry or physics; December 31, 1904 a Charles Lagrange prize for

terrestrial physics; on May 1, 1906, a Selys Longchamps prize for researches on the Belgian fauna; on December 31, 1904, a Théophile Gluge prize for physiology; and in 1906 a François Deruyts prize for higher synthetic or analytic geometry.

MR. BALFOUR presided on July 14 at the annual dinner of the Royal Economic Society, of which he is vice-president. In proposing the toast "The Royal Economic Society," he said in the course of his remarks:—"If a man of science once lets the public think that he is speaking not in the interests of his science, but in the interests of his party, if he once allows the view to get abroad that his expression of opinion may have its origin in his scientific views, but has a double parentage, and that the scientific views are in some sense moulded in conformity with our political differences, his whole authority from that moment will absolutely vanish. So far as political economy is a science at all—and I am the last person to deny it that proud title to distinction—it must be absolutely international in its character. People talk of an English, a German, a French, or an American school of political economy. In so far as they talk in that way they show conclusively that political economy to that extent has not yet thoroughly earned its title to a position among the sciences. There is no such thing as English physics as distinguished from German physics, or German mathematics as distinguished from French mathematics. I do not say there may not be certain schools having the impress of great teachers belonging to one or the other nationality, but *qua* science and as a science political economy must be, and is, and will be, absolutely international in its character. Let everybody who has the chance, not only treat economic problems in a strictly objective spirit, but let him make it clear that that is the spirit in which he is trying to treat them. Thus and thus only will the student and the investigator obtain that authority over the changing forces of ordinary public opinion which it should be the proudest boast of men of science to obtain, which if they truly pursue science in a scientific spirit they have always obtained in the past, and I cannot doubt for a moment they will always obtain in the future."

The second part of vol. v. of *Annotationes Zoologicae Japonenses* contains the description of a new deep-sea polychæte annelid by Prof. A. Isuka, additional notes on Japanese cicadas by Prof. S. Matsumura, and the first part of a biological and geological essay on the island of Hokkaido by Mr. E. Klocke.

IN reply to a question of Mr. Morrell, not answered orally in the House of Commons, Sir W. Anson stated that the Board of Education is aware that those interested in agricultural investigation recognise the value of the drift maps prepared by the Geological Survey as a basis for soil maps. Superficial deposits are being mapped in all districts where work is going on in connection with the survey. Thirty-five 6-inch maps of North Staffordshire have been published with drift, and others of South Wales and of the area around Leicester are in course of preparation for publication. The board does not contemplate the publication of drift maps on the 6-inch scale for the entire country, but manuscript maps of any part surveyed on this scale may be obtained at the cost of copying, and whatever information with reference to superficial deposits the officers of the survey have shown upon their field maps of other parts of the United Kingdom is available for reference at the offices of the Geological Survey.

IN *La Nature* of July 9, M. J. R. Plumandon, of the Puy de Dôme Observatory, contributed an interesting article on the dryness of the air. "Relative humidity," or the percentage of saturation of the air with aqueous vapour, plays a more important part in meteorology than "absolute humidity"; its variations produce or dissipate clouds, and give rise to fine or wet weather, it is always irregularly disseminated in the atmosphere, its diurnal variation following inversely the range of temperature, and its annual variation generally exhibits a maximum in winter and a minimum in summer. But almost everywhere it exhibits another minimum in spring-time which frequently exceeds that of summer. The minima, or in other words the periods of dryness of the air, present the greatest interest, owing to their irregularity both as regards date and intensity. M. Plumandon shows by means of very clear diagrams that the annual minimum is more marked, and occurs at varying periods, according to the greater altitude of the station. Near Paris, at a height of 50 metres, it always occurs in spring, while on the summit of the Pic du Midi (2859 metres) it occurs at all seasons. At Toulouse (194 metres) the greatest dryness of the air occurs nearly always in summer, but sometimes also in spring. At Clermont-Ferrand (338 metres) it occurred in spring in twenty-one years out of twenty-five, and at the summit of the Eiffel Tower (also 338 metres) it occurred in March or April in seven years out of eleven. On the Puy de Dôme (1467 metres) it took place in twenty-one years out of twenty-two during the cold season, between September 20 and March 1. The diagrams also show the intensity of the minima in the various months.

M. POTIER has presented a large and valuable collection of pamphlets and works on physics to the French Physical Society for distribution among any members of the society who are interested in the particular branches of which they treat.

IN several recent numbers both in this and last year's volumes of the *Bulletin international* of the Cracow Academy, Prof. Ladislaus Natanson discusses the phenomenon of accidental double refraction in liquids and its connection with the theory of relaxation. The author further criticises papers by M. St. Zaremba, who also contributes a number of writings on the same subject to the same journal.

IN the June number of the *Journal* of the Royal Microscopical Society, Mr. Keith Lucas describes a microscope in which the usual planed sides of the body-tube and limb are replaced by geometric slides. The instrument thus involves an adaptation to biological and other microscopes of a device the use of which has hitherto been generally restricted to measuring microscopes.

FROM Messrs. Ulrico Hoepli, of Milan, we have received the latest issue of their "Biblioteca scientifico-politecnica," a catalogue extending to more than three hundred pages, and comprising scientific and technical works and periodicals published both in Italy and in other countries, up to the end of 1903. In all cases where foreign works have been translated into Italian the translation is mentioned in this catalogue.

A SECOND and enlarged edition has been issued of Prof. Augusto Righi's small book on "La moderna teoria dei fenomeni fisici," in which the author describes modern views on radio-activity, ions, and electrons. The book forms the third of a series published by Nicola Zanichelli, of Bologna, under the title "Attualità scientifiche." It extends over 165 pages, and contains a fairly complete bibliography of the subject.

IN a paper on "Edge Corrections in Condensers," communicated to the *Proceedings* of the American Academy of Arts and Sciences, Mr. J. G. Coffin works out a number of electrostatical problems in two dimensions by the conformal transformation of Schwarz and Christoffel. The problems here considered include as particular cases many of the cases solved in Prof. J. J. Thomson's book, and they have application to condensers, such as one formed of two silvered glass plates, the capacities of which have not previously been determined.

IN his presidential address to a joint meeting of the American Physical and Mathematical Societies, delivered in February last, Mr. Arthur G. Webster chose as his subject "Some Practical Aspects of the Relations between Physics and Mathematics." The address has been reprinted in the *Physical Review* for April, and deals with the work of the late Prof. Willard Gibbs, the endowment of research, and the relative parts played by mathematical and physical teaching and general culture in the education of the physicist in schools and colleges.

SOME interesting properties relating to the polarisation of electrodes are described by M. E. Rothé in the *Bulletin* of the French Physical Society, No. 214. In particular the author obtained a deposit of hydrogen on a platinum wire with a single Daniell cell when the anode was a large lamina, although 1.7 volts would be required to decompose water in ordinary circumstances. This deposit ceased when the anode became polarised by the absorption of oxygen. It thus appears that gas may be deposited on a *single* electrode when the electromotive force is just sufficient to overcome the counter-electromotive force of that electrode alone.

AN account of the department of international research in terrestrial magnetism of the Carnegie Institution is given in *Terrestrial Magnetism and Atmospheric Electricity*, ix., 1. The object of the department will be to investigate such problems of world-wide interest as relate to the magnetic and electric conditions of the earth and its atmosphere, not specifically the subject of inquiry of any one country but of international concern and benefit. Among the problems suggested are a magnetic survey of ocean areas and unexplored regions, international observations of the variations, including the establishment of secular variation or repeat stations throughout the globe, observations in ocean depths and atmospheric regions (for which the first step consists in devising suitable instruments), and other problems.

AT the recent show of the Royal Agricultural Society, the new Just-Hatmaker process for drying milk was exhibited. The milk is fed continuously on two cylinders, one-eighth of an inch apart, and revolving inversely. These are heated by superheated steam within, and have a surface temperature of 110° C. The milk passing between the revolving cylinders forms a thin layer on each, becomes evaporated to dryness, and is stripped off as a thin sheet of milk solids, all within a single revolution. The thin sheets are reduced by sieving to a powder, which can be compressed into tablets. Mixed with warm water the powder immediately forms a liquid having all the properties of boiled milk. The advantage to travellers of having milk in a concentrated form—the powder contains only 6 per cent. of moisture—is obvious. Moreover, the dry milk as it leaves the machine is completely sterilised. With rennet or acid we find that the mixture of dried milk and water curdles, but the curd is not coherent, a property which may add to its digestibility but destroys its value for certain culinary purposes. Owing to its cooked taste, the new product can never replace fresh milk, so that its introduction is no menace to the British milk industry; on the contrary, farmers should benefit if the milk supply associations they deal with possess this apparatus for drying any surplus over the daily requirements. The public will find that discrimination is necessary in the purchase of the dried milk, as it can be made from either whole or separated milk.

WE have received a copy of the fifth annual report of the Plymouth Municipal Museum and Art Gallery, in which an unusually large number of presentations to that institution are recorded.

IN the July issue of *Bird Notes and News* the Society for the Protection of Birds directs attention to the extent of the trade in cage-birds, and the evils attendant on the capture and maintenance in captivity of such birds. The subject is emphasised in the case of the linnet by a special leaflet, "A Linnet for Sixpence," in the course of which it is stated that sixty per cent. of these birds perish during the first week of captivity, in addition to others killed in capture and the number of hens wantonly destroyed by their captors. The practice of selling in London cock-linnets in paper-bags for sixpence is specially deprecated.

THE *Popular Science Monthly* for July contains an illustrated account by Prof. Bashford Dean of the zoological station at Misaki, Japan. The station, which was removed to Misaki in 1897, now contains two buildings with convenient workrooms, for which fittings and books are periodically sent from Tokyo in accordance with the needs of investigators. The great feature of the station is the crew of fishermen, who are accustomed to carry on their trade in deep water, with lines which may be as much as a mile in length, and often bring up rarities. The shallow water of the bay yields numerous interesting types—among others a giant Balanoglossus—while from deep water further out are obtained the remarkable shark Mitsurikina, perhaps identical with the Cretaceous Scapanorhynchus, the frilled shark (Chlamydoselachus), and one of the Port Jackson sharks, in addition to numerous interesting invertebrates, such as swarms of glass-sponges and specimens of the stalked crinoid Metacrinus.

IN No. 10 of vol. ii. of the *Circulars and Agricultural Journal* of the Royal Botanic Gardens, Ceylon, the director, Mr. J. C. Willis, gives an account of the history of the institution; originally simply a botanic garden at Peradeniya, it has gradually developed into one of the greatest botanical and agricultural establishments in the tropics, comprising six botanic gardens with a cultivated area of 256 acres in different climates and elevations, three experiment stations of a total cultivated area of 360 acres, and forest reserves for scientific purposes of 850 acres. There is a European staff of nine, including four botanists, an entomologist, and a chemist, and well equipped laboratories, library, museum, and herbarium, all open freely to workers from abroad. No less than twenty-two scientific men have visited Peradeniya for purposes of original research during the last seven years, and the institution now publishes a botanical journal devoted to pure research.

"THE Fungous Diseases of Fruits in Michigan" forms the title of a special *Bulletin* prepared by Mr. Longyear and issued by the Michigan State Agricultural College. The author has brought into a small compass the diagnoses of fungal pests which attack common fruit trees and plants, together with hints as to preventive or remedial treatment.

SEEING that no comprehensive account of the flora of Norfolk Island has been published since Endlicher's "Pro-

dromus Floræ Norfolkicæ," which came out in 1833, the contribution to this subject presented by Mr. J. H. Maiden to the Linnean Society of New South Wales last year is eminently useful. The paper begins with a critical enumeration of the flowering plants and cryptogams, in which the author deals with a number of synonyms and doubtful references, besides adding several new records for the island. A somewhat novel feature for a flora is a separate list of plants of economic and horticultural value. The author reserves for a second part his observations as to origin and distribution.

SOME interesting ecological observations of certain swamp areas in Michigan and Arkansas counties, U.S.A., are recorded by Dr. S. M. Coulter in the fifteenth annual report of the Missouri Botanical Garden. On the island of North Manitou, in Lake Michigan, a small lake, having no outlet, is being filled up by the encroaching vegetation. The pioneer plants are the peat-mosses, followed by cranberry and leather leaf, *Cassandra calyculata*; tamarack, *Larix Americana*, and black spruce crowd on the shrubs, and as the ground gets drier deciduous trees obtain a foothold. In the swamp region of the St. Francis River two characteristic trees are found, the tupelo gum, *Nyssa uniflora*, distinguished by having a continually increasing dome-shaped base, and the bald cypress, *Taxodium distichum*, which develops a conical butt and peculiar "knees."

DR. N. ZARUDNY has returned from his last journey to Persia, and has brought back rich ornithological collections.

WE learn from the *Bulletin* of the Russian Society of Naturalists of St. Petersburg that the biological station which has been established near Alexandrovsk, on the

FIG. 1.—The biological station on the Norman coast of the Kola peninsula, North Russia. View from the north-west, at low water. The pumping machinery and a covered sea-water basin are shown on the left.

Norman coast of the Kola peninsula, is now in working order. It is provided with all the necessary apparatus for pumping sea-water to a basin and an aquarium, as well as with a special sailing boat and all apparatus required for fishing and dragging. During last summer the exploration of the bay and its nearest surroundings proved that both yield rich material for research. The sea-bottom opposite the Dog's Cape of Catherine Island is covered with Lithothamnium, upon which there are many annelids (*Nereis pelagica*, *Glycera capitata*, &c.), numerous worms, the *Cucumaria frondosa* and *C. calcigera*, *Psolus phantapus*, many Ophiuridæ, Planariæ, Nemertinæ, a variety of crustaceans and molluscs, two Actiniæ, one of which is the *Actinoloba dianthus*, the deep-water medusa, *Pectyllis arctica*, and many other forms of life. Altogether it appears that within a distance of less than one and a half miles from the station there is already a deep-water fauna which lives at the comparatively small depth of from 20 to 70 fathoms.

IT has been generally considered that the naphtha wells of the Kuban province of north-western Caucasus take their origin in the Sarmatic and Mediterranean layers of the Tertiary deposits of that region. The mining engineer, W. I. Wind, brings forward (in the *Bulletin* of the St. Petersburg Society of Naturalists, 1904, No. 4) some data tending to prove that naphtha in Kuban originates also in deeper lying Tertiary strata which consist of a dark, almost black clay, containing enormous quantities of remains of fishes (chiefly Meletta), as well as thin layers of carbonised plants.

A NEW instalment of "Flora Caucasica critica," by N. Kuznetsoff, N. Busch, and A. Fomin (fascicules 3 to 6), appears in the *Memoirs* (*Trudy*) of the St. Petersburg Society of Naturalists, vol. xxxii., part iii. A special fascicule of the same volume is devoted to the memory of A. Beketoff, and contains the following works:—"The Influence of the Concentration of Solutions on Respiration and Exchange in Plants," by V. Palladin and Mme. A. Komleva; "The Influence of Wounds on the Formation of Unassimilable Albumens and Nucleo-proteids in Plants," by I. Kovshoff; "The Vegetation of the Povyenets District of Olonets," by E. Ispolatoff; "On the Vegetation Covering the Sands in Taurida," by the same author; "The Influence of Exterior Conditions on the Division of Nuclei in the Roots of *Vicia faba*," by V. Sablin; and "On the Influence of Saccharose on the Respiration of Seeds," by S. Woicehowski.

A NEW edition of Dr. H. R. Mill's "Elementary Class-book of General Geography" has been published by Messrs. Macmillan and Co., Ltd. The book, which first appeared in 1889, was largely re-written in 1900, and has again been thoroughly revised. Recent political changes and colonial developments have been noted, and all statistics have been brought up to date by reference to the returns of the censuses of 1900 and 1901, and to recent official publications.

A SELECTION of the brilliant lectures and essays of the late Prof. W. K. Clifford, together with a biographical sketch of the author, has been published by Messrs. Macmillan and Co., Ltd., in their sixpenny series. In their cheap form these essays and addresses should be widely read, and there is every reason to hope that Clifford's influence will be increased greatly by the publication of his teachings at this small cost.

WE have received from Messrs. John J. Griffin and Sons, Ltd., a copy of a new issue of their illustrated catalogue dealing with apparatus for the study of magnetism and electricity. Among other novelties, particulars of which are given in the catalogue, we notice moving coil voltmeters and ammeters which can be obtained at a reasonable price, and apparatus for showing Prof. Elihu Thomson's experiments on the electromagnetic repulsion between an alternating electro-magnet and a conducting ring. The convenient arrangement of the catalogue and the large number of illustrations it contains should render the publication of real service.

A NINTH edition of the late Prof. Babington's "Manual of British Botany" has been published by Messrs. Gurney and Jackson. The book has been enlarged from the author's manuscripts and other sources. The work of editing the new edition has been done by Messrs. Henry and James Groves. Species, varieties, additional characters and remarks which have been inserted by the editors are printed in smaller type, and where introduced in the text

are enclosed in square brackets. A fresh account of the genus Hieracium has been drawn up by Miss R. F. Thompson and included in the book. A conspectus of the groups and species from the "Handbook of British Rubi," by the Rev. W. Moyle Rogers, has, by permission, been added as an appendix.

SINCE its publication in 1894, Preston's "Theory of Heat" has been regarded as a standard work on the subject. Teachers and students will welcome the new edition which has just been published by Messrs. Macmillan and Co., Ltd. The revision, necessary in view of the recent progress made in this branch of physics, has been done by Mr. J. Rogerson Cotter, of the University of Dublin. Among the changes in the new edition may be mentioned the transference of the section on the dynamical equivalent of heat from chapter viii. to chapter iv., a few unimportant omissions, and the addition of some hundred pages of new matter. The additions have been enclosed in brackets. Mr. Cotter has succeeded in bringing the book well up to date, and in this way has ensured a continued popularity for an excellent treatise.

AN interesting and simple mechanical model devised for the purpose of illustrating to students the gas laws and the nature of Carnot's cycle is described by Dr. F. B. Kenrick in the May number of the *Journal of Physical Chemistry*.

WE have received a copy of the *Chemikalien-Zeitung*, a new journal to be published fortnightly under the editorship of Dr. R. Pauli, Berlin. The journal will be devoted to matters relating to the manufacture and application of chemical substances in the industries. One of the chief objects of the promoters is to produce by means of the fortnightly publication a work of encyclopædic character dealing with this aspect of technical chemistry.

WE have received vol. i., No. 1, of the *Memoirs* of the College of Science and Engineering, Kyoto Imperial University, a publication containing original papers by members of the university. Among other papers worthy of notice are "Synthesis of Indigo and its Methyl Derivatives," by M. Kuhara and M. Chikashigi, and "Defects of Uncarburetted Water Gas as Fuel for Laboratory Use," by M. Chikashigi and H. Matsumoto.

IN the *Physikalische Zeitschrift* (No. 12, 1904), Messrs. Elster and Geitel describe a new form of electroscopic apparatus for the investigation of feebly radio-active bodies. With this a large number of different kinds of earths, minerals, lavas, and water deposits has been examined. The activity of the sedimentary deposits from the hot springs at Baden-Baden is remarkably high, the sludge deposited at the source having approximately the same activity as uranyl potassium sulphate. As the distance of the deposited matter from the source increases, its activity falls off rapidly.

SOME recent experiments by M. Henriet communicated in the *Comptes rendus* (vol. cxxxviii. p. 1272, 1904) show that formaldehyde is present in considerable quantity in the atmosphere. The method of estimation consists in aspirating the air through a tube containing red oxide of mercury heated to 250° in which the formaldehyde is oxidised to carbonic acid, which is then absorbed in potash bulbs. The carbonic acid already present in the original air has to be subtracted from the amount thus found, and the difference corresponds to formaldehyde. In 100 cubic metres of normal air formaldehyde is present to the extent of 2–6 grams.

IN view of the high atomic weight of radium and the remarkable ionising properties of the salts, it would not have been surprising if the electrolytic properties of radium bromide had been altogether abnormal. That this is not the case is clearly shown by the recent measurements of Kohlrausch and Henning, published in the *Verhandlung* of the German Physical Society (vol. v. pp. 144–6, March 15). The electrical conductivity is perfectly normal over the range from N/20 to N/12,000, and closely resembles that of the corresponding barium salt. The molecular conductivity rises from 100·0 to 123·6 over this range of dilution, and the limiting value is given as 125. The mobility of the radium ion is therefore 57 as compared with 56 for barium, and 53 for strontium and calcium. It is of interest to note that Runge and Precht's value for the atomic weight would give an altogether abnormal value, 67, for the ionic mobility.

WE find in the *Bulletin* of the Society of Naturalists of St. Petersburg (1904, No. 3) an interesting paper, by N. Karakash, based on a recent journey of A. Zhuravskiy and on previous exploration, giving some idea about the little known eastern portion of the tundras of Arkhangelsk, which is known as the Bolshezemelsk tundra, and lies between the Petchora and the northern Urals and the Pai-hoi Range. This portion of the tundra has not the flat and marshy character which it has in the west, but it is covered with mounds, hills, and narrow low ridges of Boulder-clay, reaching a height of 100 and occasionally 200 feet, and a length of from 12 to 20 miles. Between these mounds and hills are found countless lakes, marshes, and spaces which can be described as true patches of the tundra. All these hills are undoubtedly of morainic origin, the Boulder-clay having only been washed by water on its surface and covered here and there with sand. As to the boulders, they consist of granites, porphyrites, gneisses, and various metamorphic slates, as also of limestones and sandstones. The latter contain Devonian, Carboniferous, and Carbo-Permian fossils, such as are well known from the western slopes of the Urals, as also Permian and Jurassic fossils, such as are known further south in the basin of the Petchora. Traces of a post-Glacial sea have only been found near the shores, but it is known from the previous researches of Barbot-de-Marny, Tchernysheff and others that large spaces of north-eastern Russia, up to a level of about 120 metres, were covered by the sea during the post-Glacial period.

OUR ASTRONOMICAL COLUMN.

RADIAL VELOCITY OF THE ORION NEBULA.—From the measurement of a series of spectrograms of the three brighter stars in the trapezium of Orion, Messrs. Frost and Adams have determined the radial velocity of those parts of the nebula located by these stars. Seven plates of the star θ^1 Orionis (October, 1903, to February, 1904) gave a mean velocity for the nebula of +19·3 km., three plates (December, 1903, January and February, 1904) of the star Bond 640 gave 18·0 km., and one plate (March 8, 1903) of the Bond star 619 gave +14 km. The general mean was +18·5 km., which is slightly higher than the values obtained by previous observers, *e.g.* +17·7 km. obtained by Keeler in 1890–91. Surprise is expressed as to the low value determined for the last named star, as the plate measured was an exceptionally good one, but the observers hesitate to draw conclusions from the results obtained from one plate.

The radial velocities of the stars themselves were also determined from the dark-line spectra on the same plates, and the provisional values are given for the two Bond stars. Regarding θ^1, the peculiarities of the spectrum and the binary character of the star will necessitate the study of a much greater number of plates before definite values can be obtained. For Bond 640 a mean value of +20 km. was determined, whilst for Bond 619 a value of +48 km., strikingly greater than that of the nebula, was obtained.

The same observers also publish the results of similar

observations of four stars of the Orion type (9 Camelopardi, κ Cancri, μ Sagittarii, and δ^1 Lyræ) which have variable radial velocities (*Astrophysical Journal*, No. 5, vol. xix.).

MASS AND SHAPE OF JUPITER.—At the June meeting of the Royal Astronomical Society, Mr. Bryan Cookson read a paper giving the results of a series of heliometer observations of Jupiter's satellites made by him at the Cape Observatory during 1901–2.

Within two months of the opposition of the planet he made 783 observations of the satellites in distance and position angle. The values obtained for the mass were

$$1 : 1047{\cdot}69 \pm 0{\cdot}09 \text{ and } 1 : 1047{\cdot}66 \pm 0{\cdot}06$$

during 1901 and 1902 respectively. These agree very well *inter se*, but differ considerably from Prof. Newcomb's adopted value of 1 : 1047·35, a difference which has yet to be explained or eliminated.

The value for the compression-constant of the planet was also different from the adopted value, being 11 per cent. greater. As determined in the paper, the ellipticity is 1 : 15·8, but direct measurements of the equatorial and polar diameters gave 1 : 16·5. Part of this difference may be real, but part may be due to the difficulty experienced in measuring the planet's diameter (*Observatory*, No. 346).

"REVERSALS" IN SUN-SPOT SPECTRA.—In a paper appearing in No. 5, vol. xix., of the *Astrophysical Journal*, Mr. W. M. Mitchell, of the Princeton (N.J.) Observatory, publishes the results of four sets of observations, made during March and April with a Rowland grating spectroscope (20,000 lines) attached to the 23-inch refractor of the Halsted Observatory, of the lines reversed in sun-spot spectra in the region λ 6770 to λ 4915. The number of lines more or less affected in this region was more than 270, and Mr. Mitchell gives a table containing about 70 lines which were found reversed, and 6 lines which were thinned. In the region C–D about 35 per cent. of the lines affected were seen reversed, whilst for a further 5 per cent. the appearance of reversal was too uncertain to give definite results. The C line was observed partially reversed on April 8, but the *b*, E, and D groups were never affected. D_3 was not seen at all.

ESCAPE OF GASES FROM THE EARTH'S ATMOSPHERE.—In a communication to the *Philosophical Magazine* (June, 1904) Dr. Johnstone Stoney directs attention to a recent letter from Mr. S. R. Cook, published in NATURE (March 24), on the "Escape of Gases from Atmospheres." After stating that he arrived at the same conclusion as Mr. Cook, by the same methods, thirty or forty years ago, and has since had to abandon that conclusion, Dr. Stoney shows that the flow of helium from springs into the earth's atmosphere is from 3000 to 6000 times more than can be accounted for by the minute quantity dissolved by the rain in falling, yet the relative quantity of helium in the atmosphere apparently remains constant. Therefore, he says, helium *is* escaping from the atmosphere, the rate of escape being equal to that of the influx. Further, Dr. Stoney also shows that theoretically the conditions under which the flights of gaseous molecules take place in the upper atmosphere sufficiently explain the outflow, as it would only be necessary for the chance of escape for each molecule to occur once in several days in order to account for the amount received by the atmosphere from the earth.

FORTHCOMING RETURN OF ENCKE'S COMET.—In No. 6, vol. i., of *Knowledge and Illustrated Scientific News*, Mr. Denning publishes a few notes in reference to the return of Encke's comet during the coming autumn. Due at perihelion on January 4, it should be observable in large telescopes about August or September, and will be nearest the earth, at a distance of about 35,000,000 miles, in the third week in November. On October 4 it will apparently be about half-way between β Andromedæ and α Trianguli, thence, travelling westward, it will arrive at about 5° N.E. of β Pegasi on November 1.

The present period, according to Prof. Seagrave, is about 1206d. 20·25h., and during the coming apparition the favourable conditions of 1805, 1838, and 1871 (period 33 years) should be repeated. It is possible that early in December, when close to Altair, the comet may be visible to the naked eye.

THE UPPER CHALK OF ENGLAND AND ITS ZONES.

WE have received two important contributions to our knowledge of the Upper Chalk in this country. The one on "The Upper Chalk of England" is the third and concluding volume of Mr. Jukes-Browne's memoir on the Cretaceous rocks of Britain, issued by the Geological Survey (price 10*s*.). It is a goodly volume of 566 pages, in which the stratigraphical features of the Upper Chalk and the fossils of the successive zones are very fully dealt with. As in previous volumes, Mr. William Hill has contributed particulars of the microscopic structure of the Chalk. The ample topographical and palæontological descriptions of the Chalk will enable the student readily to ascertain what is known, and the author has been fortunate in being able to embody the results of a great part of the recent work accomplished by Dr. Rowe. In one chapter he discusses the bathymetrical conditions during the formation of the Upper Chalk, pointing to facts presented by the Chalk rock-beds which indicate a general upheaval of the British area. Later on, during the period of the Micraster and Marsupite zones, evidence of subsidence is afforded, and this was probably succeeded by re-elevation during the time of the Belemnitella zone. This volume contains a general account of the economic products of the Chalk, including water-supply, and reference is made to the bournes or nail-bournes, notable examples of which, as at Croydon and elsewhere, have recently manifested themselves. The Chalk escarpments and other features of Chalk districts are described. There is also a general list of all the known fossils from the Chalk of England, with references to zones and localities, and there is a full bibliography. Mr. Jukes-Browne is to be congratulated on the completion of this exhaustive work. We only wish that it had been somewhat better illustrated.

Turning to the other work, "The Zones of the White Chalk of the English Coast, part iv., Yorkshire," by Dr. Arthur W. Rowe, we find a work of a little more than a hundred pages, with twenty-two beautiful photographic plates and other illustrations, issued by the Geologists' Association (vol. xviii., part iv., price 3*s*.).

The previous portions of Dr. Rowe's work on the zones in Kent and Sussex, in Dorset and in Devon, have been already noticed in NATURE. The present part is the result of "42 days of steady work" on the cliff-sections and adjacent chalk-pits of the coast near Flamborough Head. The time seems limited (as the author observes), but as he went fortified with the accumulated knowledge and experience of many years' assiduous study, and was accompanied, as before, by Mr. C. D. Sherborn, he was ready and able to make the fullest use of his time. When he refers to the region as "a veritable *terra incognita*" we can hardly agree with him, despite his own saving clauses. But that he has enriched our knowledge to a very large extent, as he invariably does, was inevitable, and all geologists will rejoice.

The essay itself fills the reader with enthusiasm, for it is written with vigour and with a heartiness that is contagious. The work proved less easy, though not less interesting, than was anticipated. The record of the fauna was found to constitute "a veritable zoological romance."

It was "wholly impossible to institute any valid comparison between this marvellous coast and any of the sections which we had previously described." The variations in the distribution and range of the species, the rarity of zonal guide-fossils, the hardness of the rocks, to say nothing of the difficulties of getting at the strata, were alike remarkable. At the same time the results of Dr. Rowe's work afford "overwhelming proof of the validity and homogeneity of the zonal theory," and we cordially commend the work to all students. In an appendix Mr. G. W. Lamplugh contributes some notes on the conditions of accumulation of the Yorkshire Chalk, and refers to the finding of an ammonite, 3 feet in diameter, beneath which was an agglomeration of small fossils, evidently protected from decay by the huge ammonite. He remarks that a considerable portion of the Chalk was probably due to the pulping-down of calcareous bodies by lowly organic agencies. Referring back to Mr. Jukes-Browne's volume

(p. 343), we learn also from Mr. W. Hill that "As a whole the amorphous material of the Upper Chalk appears to be made up almost entirely of the débris of calcareous organisms."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Dr. Harold A. Wilson has been elected senior lecturer in physics at King's College, London, and Mr. S. C. Laws junior lecturer.

On July 27 Sir Thomas H. Elliott, K.C.B., Secretary to the Board of Agriculture, will open the extensions of the Midland Agricultural and Dairy Institute at Kingston-on-Soar.

Prof. Chantemesse has, at his own request, been transferred to the chair of hygiene at the University of Paris, vacant through the death of Prof. Proust. The chair of experimental pathology thus vacated has been filled by the appointment of Dr. Roger to succeed Prof. Chantemesse.

We learn from *Science* that Mrs. Henry Whitman, of Boston, has made public bequests amounting to more than 40,000*l.*, including 22,000*l.* to Radcliffe College and 2000*l.* to Harvard University; and that Mr. George Ehret, of New York, has given 2000*l.* to the permanent fund of Hamilton College.

Mr. H. A. Clark, late assistant lecturer in engineering at the University of Leeds, has been appointed head of the engineering department of the Northern Polytechnic Institute, London. Mr. Clark was Ramsbottom scholar at Owens College, Manchester, a Whitworth scholar, and is an associate of the Royal College of Science.

The first annual report of the University Extension Guild has now been published. The object of the association, which was founded last December, is "to promote among all classes, at times convenient to all, the extension of university teaching." The report states that the work accomplished and the influence exerted by the guild have been considerable, and give great hopes of success in the future. The honorary secretary of the guild is Mr. Max Judge, 7 Pall Mall, S.W.

The Montgomery County Council recently discussed a resolution, passed at the Swansea conference of county council delegates, recommending to county councils the establishment of schools of forestry, and the giving of grants to existing colleges. The chairman said all are agreed that planting is a very desirable agricultural improvement, and that the management of woods in many cases leaves much to be desired. It would be, he continued, for the advantage of the country if the council provided forestry instruction in addition to the instruction they had provided in other branches of rural pursuits, and at his suggestion delegates were appointed by the council to attend a conference to be held for the purpose of discussing the question.

The Prince of Wales, who was accompanied by the Princess of Wales, on July 16 laid the foundation-stone of the new buildings of the Working Men's College, which was founded by F. D. Maurice. The plans of the new buildings show a hall to accommodate 250 persons, common rooms, club rooms, and gymnasium for the students, a library fitted for 10,000 books, and a museum. There are added electrical and chemical laboratories, with which the old college was not equipped. Altogether there is teaching space provided for 700 students. Replying to an address—read by the principal of the college, Prof. A. V. Dicey—the Prince of Wales expressed his cordial sympathy with the aims and objects of the college, which are to bring within reach of the working classes the means of knowledge and culture. As the Prince of Wales said later, "the Working Men's College has seen its aims fulfilled and its pioneer work taken up and extended by those numerous and great institutions for commercial and technical instruction which have been established in the capital and in all parts of the Empire."

The importance of establishing a national school of forestry was recently urged by the Association of Chambers of Commerce. The following reply has been sent to the association by Sir Thomas Elliott, on behalf of the Board of Agriculture:—"The President of the Board of Agriculture and Fisheries fully recognises the importance which attaches to the question of afforestation and to the provision of a national system of instruction in forestry. Steps have already been taken in more than one direction to give effect to the recommendations of the departmental committee which was appointed in 1902, under the chairmanship of Mr. R. C. Munro Ferguson, M.P., to inquire into the subject. Through the agency of the Commissioners of Woods and Forests a school of forestry has been established in the Forest of Dean, and a movement is on foot for securing a suitable area of land in Scotland for the purpose of demonstrating scientific forestry. The Board has taken steps to secure the establishment of at least two lectureships in forestry in England, and some of the leading universities and agricultural colleges have been giving attention to proposals under this head. The agricultural departments of the University College of North Wales, Bangor, and of the Durham College of Science, Newcastle-upon-Tyne, appeared to offer special advantages as centres of instruction in forestry, and grants in aid of the establishment of schemes of education in the subject will be made by the Board to those institutions. The Board hopes that the arrangements thus made will result in a considerable improvement of the facilities available in this country for the acquirement of a knowledge of practical forestry."

The following are among the awards of Carnegie research fellowships, scholarships, and grants for the academic year 1904–5, under the Carnegie trust, for the universities of Scotland:—Fellowships.—*Physical*, D. B. McQuistan; *Chemical*, C. E. Fawsitt, Dr. J. C. Irvine, W. Maitland; *Biological*, J. Cameron, Dr. F. H. A. Marshall, H. J. Watt; *Pathological*, C. H. Browning, J. C. G. Ledingham, S. A. K. Wilson. Scholarships.—*Physical*, P. D. Innes, H. W. Malcolm, J. H. Maclagan Wedderburn, J. R. Milne; *Chemical*, Adam Cameron, W. A. K. Christie, F. W. Gray, J. Johnston, F. J. Wilson, J. Wood; *Biological*, Margaret T. Hamilton, W. D. Henderson; *Agricultural*, S. F. Ashby, C. Carter; *Physiological*, J. S. Rose; *Pathological*, C. M. Campbell, R. D. Keith, W. G. Rodger. Grants.—*Physical*, G. A. Carse, Prof. MacGregor, T. Oliver, W. Peddie; *Chemical*, Prof. G. G. Henderson and Dr. Gray, Dr. A. N. Meldrum; *Biological*, Dr. J. H. Ashworth, Dr. J. Beard, Cyril Crossland, Prof. J. Cossar Ewart, Prof. Paterson, Dr. John Rennie, W. G. Smith, Dr. D. Waterston, Dr. J. H. Wilson, Prof. R. Patrick Wright and A. N. M'Alpine; *Anatomical*, E. B. Jamieson; *Pharmacological*, Prof. R. Stockman; *Pathological*, Dr. J. K. Love, E. Bramwell, Prof. Carstairs C. Douglas, A. H. Edwards, Dr. A. Goodall, J. M. Kirkness, Prof. Robert Muir, Peter Paterson, W. B. Inglis Pollock, B. P. Watson, Dr. J. M. Bowie, Dr. James Scott, D. C. Watson. The twenty-four scholarships, twelve fellowships, and thirty-five grants awarded for 1904–5 amount in all to 5300*l.* The amount expended by the trust under this scheme for 1903–4 was 3400*l.*

SOCIETIES AND ACADEMIES.

London.

Royal Society, May 19.—"On the Liquefied Hydrides of Phosphorus, Sulphur, and the Halogens as Conducting Solvents." Parts i. and ii. By D. **M'Intosh**, B. D. **Steele**, and E. H. **Archibald**. Communicated by Sir William Ramsay, K.C.B.

In this paper the behaviour of phosphuretted hydrogen, sulphuretted hydrogen, hydrogen chloride, bromide, and iodide as conducting solvents has been investigated, and, in order to try and explain certain abnormalities in the variation of conductivity with concentration of their solutions, the following physical constants have been determined. (1) The vapour pressure curves from which the melting and boiling points are obtained. (2) The densities at various temperatures. (3) The molecular surface energies; from these it is seen that the hydrides of phosphorus and chlorine when liquefied are more or less associated to form complex molecules, whereas the remaining compounds occur as simple molecules. (4) The viscosity temperature coefficient. This was measured in order to compare with

the temperature coefficient of electrical conductivity. (5) Solubilities and conductivities. A large number of substances were examined, and it was found that many organic compounds containing oxygen or nitrogen dissolved readily in HCl, HBr, HI, and H_2S, and formed solutions which conducted well.

Inorganic substances, on the other hand, did not dissolve, or if so only in the merest traces. An exception to the latter generalisation occurs in the case of H_2S dissolved in HBr; these liquids mix in all proportions, but the mixture does not conduct the current.

June 16.—"On Flame Spectra." By Charles de Watteville. Communicated by Arthur Schuster, F.R.S.

In order to obtain the spectrum of any substance, it has generally been considered sufficient to introduce a small quantity of it into an already formed flame. In the course of a photometrical investigation of flames which had been coloured by injecting the spray from saline solutions into the gas to be burnt, M. Gouy discovered in the spectra of the flames several new lines belonging to the metal contained in the solution (*Annales de Chimie et de Physique*, 5th series, vol. xviii., 1879). Instead of appearing throughout the whole flame, as did the previously known lines, these new lines were only emitted in the vicinity of the inner blue cone—the origin of the Swan spectrum.

The method employed by the author is, in short, that which has been introduced by M. Gouy.

The lines in the spectra obtained under the conditions of his experiments are very much more numerous than is the case when all the portions of the flame do not participate in the production of the phenomena. Moreover, the flame spectra extend sufficiently far into the ultra-violet in order to enable the line 2194 of tin to be observed.

The lines which are found in the flame spectrum are those which are the strongest lines in the arc spectrum. In certain cases, some of the more intense arc lines are absent, whereas less intense arc lines are to be found in the flame spectrum. On the other hand, none of the characteristic lines of the spark spectrum are ever seen in the flame spectrum.

There is a most striking similarity between the flame spectra of iron, of nickel, and of cobalt, and the oscillatory spark spectra of the same metals in the region included between about 4300 and 2700 Angström units. The similarity of the two spectra is so great that, except for very small differences of intensity, the oscillatory spark spectrum, which is photographed as a comparison spectrum in the centre of the flame spectrum, appears to be a prolongation of the latter. In the ultra-violet the spectrum of the flame appears to fade away a little more rapidly than that of the oscillatory spark, but it is probable that this difference would be reduced by prolonging the time of exposure, since it is, of course, the radiations of the shortest wave-length which are most absorbed by different media.

It is very probable that the reason for this similarity between the spectrum of the flame and the spectrum of the oscillatory spark is entirely a question of temperature. On the one hand, the increase in the number of lines of the flame spectrum obtained by the use of the sprayer may be attributed to the fact that the hottest regions of the flame take part in the production of the phenomena, and, on the other hand, the diminution in the number of lines in the spark spectrum when the spark becomes oscillatory is due to a diminution of its temperature.

NEW SOUTH WALES.

Royal Society, May 4.—Prof. F. B. Guthrie, president, in the chair.—Prof. F. B. **Guthrie** delivered the presidential address, in which he gave a *résumé* of the condition of chemistry and chemists in the State. Of the teaching institutions, the university made ample provision for teaching chemistry; about 300 students were in attendance at lectures, and about 150 doing practical work in the laboratories. In conclusion, stress was laid upon the necessity for centralising chemical research work. At present there existed the opposite tendency—to decentralise it as the departmental work grew. Personally, he would like to see established a central scientific institute, where all the scientific work could be conducted. Failing this, a great deal could be done in consolidating scientific work and increasing its efficiency by the creation of a controlling science department, which would administer the different scientific establishments under departmental control. This would be of great advantage in research, especially where it required the cooperation of more than one branch of science. Investigation into subjects of national importance could then be carried out in continuity.

June 1.—Mr. C. O. Burge, president, in the chair.—Possible relation between sun-spots and volcanic and seismic phenomena and climate: H. I. **Jensen.** This paper is a sequel to the author's note communicated to the Royal Society of New South Wales on June 4, 1902. The paper is divided into two parts. In the first part it is shown that while there has been a marked rise in solar activity since the middle of 1902, seismic and volcanic disturbances have fallen off on the earth, both in violence and frequency, almost to a minimum. In the second part of the paper various sun-spot and meteorological theories are considered. The climates of Australia and Mauritius are discussed, and the occurrence of heavy rains at sea during drought periods, the retreat of glaciers during cold winters, and the diminution in the number of cyclones during sun-spot minima are ascribed to the same cause, namely, the feebler circulation of the atmosphere due to the diminution in the amount of heat received from the sun during sun-spot minima. An index to literature and tables of earthquake and eruption statistics follow.—On the absence of gum, and the presence of a new diglucoside in the kinos of the Eucalypts: H. G. **Smith.** In this paper, which is the first of a series dealing with Eucalyptus kinos, the author shows that the supposed gum occurring in many Eucalyptus kinos is not gum, but a peculiar tannin diglucoside.—On some natural grafts between indigenous trees: J. H. **Maiden.** The author obtained from George's River a composite log which in bark and timber showed the absolute fusion of white or cabbage gum (*Eucalyptus haemastoma*, variety *micrantha*) and stringybark (*Eucalyptus capitellata*). The red timber of the former contrasts well with the pale brown of the latter, and the fusion of the two timbers is perfect. Such instances of the organic union of two species of the same genus have been rarely recorded.

CONTENTS.

THURSDAY, JULY 28, 1904.

THE GEOLOGIST AS GEOGRAPHER.

North America. (The Regions of the World Series.) By Prof. Israel C. Russell. Pp. viii+435; 7 coloured maps and 39 other illustrations. (London, Edinburgh, and Glasgow: Henry Frowde, 1904.) Price 7*s.* 6*d.* net.

THE geologist might well rest content with the usefulness of his science even if its only harvest were the revolution which it has wrought in man's conception of his mundane surroundings as expressed in the new geography. It may be that here and there the geographer still lingers who is satisfied to bound his ideas at the surface of things and to lose hold of reality in his dream of eternal seas and everlasting hills. It is true that the old geography still persists in children's school-books as ancestral customs still linger in children's games, and that the delineation of county boundaries and the names of obscure villages are still drilled painfully into the youthful mind as essentials of earthly knowledge. But the antique trammels have at least been loosened; and not in the Americas only is it that a new world has been discovered by the geographer.

We could not wish for a better exemplification of new spirit than may be found in the lucid description of a great continent which lies before us. Prof. Russell quotes with approbation the saying that "geography is the geology of to-day," and throughout his book we are made to feel that in its every aspect the present condition of the land is the evanescent expression of all preceding time. It is not without cause that "prehistoric" time is relegated, in his chart on p. 309, to the period preceding the Archæan, and that from the beginning of geological evidence he regards all time as historic.

To the geologist the sea is only land inconveniently covered by water, and we are therefore prepared to find that Prof. Russell's idea of the North American continent is not bounded by the coast-line, but includes the submerged "continental shelf." The first chapter of his book deals with this shelf, its structure, its river valleys, its marine life and its geological history, with that of the land margin by which it is bounded.

Then, in chapter ii., the topography of the land is described under the broad headings of (1) coastal plains and plateaus; (2) Atlantic mountains; (3) continental basin; (4) Pacific mountains; (5) Antillean mountains. This part of the book is vitalised by the author's wide personal knowledge of the continent, gained in the service of the U.S. Geological Survey, and by his keen sympathy in wild nature. With vivid touches of description, sure and true, and free from the cloying sentiment by which such attempts are too often overclouded, he brings before us the feeling aroused in him by the varied scenes of the wide continent. There are many passages which we should have liked to reproduce, but, lacking space, we must content ourselves by referring, as examples, to the bird's-eye view of the prairie plains (p. 97); to the expression of their straining monotony (p. 103); to the sketches of the fantastic Bad Lands (p. 111), of the glorious summits of the Californian Sierra (p. 151), and of the dense forests around Puget Sound (p. 240).

The third chapter deals with the climate of the continent, and, like every other part of the book, goes back to first principles in the course of the exposition, so that the untrained reader may gather much general as well as special knowledge by a studious perusal of it. We imagine that if the writer had been a Canadian his southern boundary for the "boreal zone," as shown on the map, plate iii., would have been somewhat differently arranged, and that it would not have included Vancouver Island and the coast of British Columbia, nor have divided Manitoba from the greater part of North Dakota. The description of the agriculture of this zone is contained in the following sentences:—

"On account of the low mean annual temperature [of the northern portion of the zone], and especially because of the shortness of the growing season, agriculture is of small importance. Along its southern border, more especially in south-eastern Canada and Newfoundland, such small fruits as currants, huckleberries, raspberries, blackberries, cranberries, &c., grow wild and yield abundant returns when cultivated. In favoured localities white potatoes, turnips, beet, and certain varieties of the apple, as well as the more hardy cereals, are cultivated with moderate success" (p. 202).

As practically the whole of Canada, except small portions of the south of Ontario and Quebec, is relegated to this zone, the above statement is decidedly inadequate. We notice also that in the margin of the map referred to there is a letterpress indication to symbols which are not visible on the map.

The plant life of the continent is described in chapter iv., wherein the characteristic features of the great forests, the cactus plains, the treeless prairies, the sage-brush lands, and the Arctic tundra are in turn presented. In this part we recognise that the author shares the repugnance felt by every good American to the term "desert" as applied to the arid lands of the western States. So, in the map which forms the frontispiece to the volume, all the sage-brush and cactus country is swept into the "grassland" division, to which term, however, the qualification, "partly with Scrub, &c.," is added in the index. Yet, even allowing for the potential irrigation of limited oases in the future, there are vast stretches that must remain, as at present, worthy only of the name of desert, and such herbage as they have is desert-herbage. In concluding his account of the plant life, the author refers briefly to the slow migration of forests under geological changes of climate by which nature, like a careful husbandman, secures a rotation of crops.

"The suggestion in this connection furnished by geologists is that we are living in a spring-time following the great winter, known as the Glacial epoch, and that the tropical, temperate, and subarctic forests are migrating northward in an orderly march, and each in turn ascending higher and higher on the more lofty mountains" (p. 257).

The discussion of the animal life occupies another chapter (v.), and here we are given a succinct account of the life-regions and life-zones, with lively descriptions of the best known representative mammals, in which again it is shown that America is or was blessed by the abundance of large herbivores and the rarity of dangerous carnivores. And how ill she deserved the blessing is also shown.

As for the birds, why!—"when one attempts to write an account of the birds of North America, the heavens seem darkened with such a multitude of varied and beautiful forms and the air filled with such a discordant clamour mingled with the sweetest of music that failure to convey an adequate idea of the countless numbers and diversity of the feathered throng within the compass of a few pages must be recognised from the start"!—wherein, somehow, we feel that The Eagle, for once, has flapped his wings.

Chapter vi., describing the geology of the continent, is the longest in the book. It claims, and defends the claim, that North America should be regarded as "the most typical" of all the continents by reason of its comparatively steady growth from one main nucleus and the resultant simplicity of its general structure. An outline of its evolution from the earliest recorded time is presented, with the inevitable incidental exposition of the fundamental principles of geology; the relation of the past to the present is clearly brought out; and the mineral resources of the continent, but more especially of the United States, are somewhat fully reviewed.

Then follows a chapter (vii.) on the aborigines, in which the author guardedly agrees with Powell "that the primordial occupancy of the continent antedates present geographical conditions, and points to a remote time which can be discovered only on geological and biological investigation" (p. 357), and he states the lines of evidence which have led to this provisional conclusion. The sad history of the outcome of the European invasion upon the original inhabitants, whether Eskimo or Indian, is briefly retold, and it is acknowledged that the Canadian Government has been less unsuccessful than that of the United States in its dealings with the natives; but the whole record is pitiful.

It is mentioned in the preface that much curtailment was found necessary in the treatment of the economic phases of geography, and in a foot-note, reference (p. 408) is made to the omission, through exigencies of space, of chapters that had been written on the geography of fisheries, forestry, mining, commerce, agriculture, &c. As it stands, the book is so full of information that he will be indeed a hardy reader who can assimilate all that is provided and still desire more. The volume concludes with a short chapter (viii.) on political geography, and in the footnote already referred to it is explained that space has been found for this part "for the reason that it presents a view of political adjustments not usually taken and in a way perhaps pessimistical, which may awaken opposition." The different kinds of political boundaries to be found on the continent are then considered, and a lament is raised that so many of the boundaries should be arbitrary where the conditions were so favourable for an ideal subdivision of territory. Here once more the wings of The Eagle are spread. The essential conditions of an ideal nation are defined (p. 421)—conditions that naturally find their fulfilment in the United States. Then (p. 423):—

"In North America, perhaps, several such eligible sites for a definite number of people might be chosen, but in no case without the drawing of unnatural boundaries. The continent, as is shown by its geology and geography, is a unit, and the most typical of comparable size of any on the earth. These same conditions point to a single political unit. Arguing from geographical relations simply, and not considering the racial differences and local self-interests, the one boundary in North America should be the shore boundary, except at the 30-mile-wide Isthmus of Panama."

In illustration of this chapter, a coloured map is given, showing in vividly contrasting pink and blue the areas respectively under "two radically different principles of government—the monarchical and the republican," or "the countries self-governed" and "those still acknowledging allegiance to hereditary rulers."

But surely there is a touch of unscientific prejudice in the insistence upon this distinction. Is not the Government of Canada to all intents, except in name, as purely democratic as that of the States—nay, is it not even more democratic when we take count of the political state of the negroes, the Indians, and the Chinese immigrants south of the border? And shall San Domingo and the Central American "republics" bear the colour of Freedom on the map which is denied to the Dominion?

Throughout the book we find that the author is at his best when describing those portions of the continent which lie within the States, but this is pardonable, or even commendable, since he is thus the better able to give the acceptable tinge of personal experience to his descriptions. Nevertheless, it is probable that Canadian geographers will feel that the background of the picture is sometimes a little out of perspective. Certainly they will object that the name of their charming mountain-resort Banff should be spelt *Bamf* (p. 126). G. W. L.

TWO METHODS OF DEFENDING FREE TRADE.

The Return to Protection. By William Smart, M.A., D.Phil., LL.D., Adam Smith Professor of Political Economy in the University of Glasgow. Pp. x+284. (London: Macmillan and Co., Ltd., 1904.) Price 5*s*. net.

Free Trade. By the Right Hon. Lord Avebury, P.C. Pp. x+164. (London: Macmillan and Co., Ltd., 1904.) Price 5*s*. net.

NOW that everyone has made up his mind as to the advisability or not of an alteration of our fiscal policy, and the question is relegated to the

political arena to be settled by political methods, it seems unnecessary to recapitulate arguments which should be familiar, and we may be content to refer readers to Lord Avebury's "Free Trade," where they will find two chapters of the "Essays and Addresses" recently reviewed in NATURE expanded and brought up to date. In it are many illuminating, if familiar, statistics and telling arguments for use by the convinced free trader; but it is not likely that a tariff reformer will be influenced by these, for it is quite obvious that his case is neither understood nor met. It is no use to repeat that we have progressed wonderfully since 1846, when the whole argument of the reformer is that the continuance of this progress is threatened. It is quite time that free traders realised that a picture of the distress prevalent in the 'thirties does not carry conviction to those who say that free trade has been good, but there are now changed conditions and a better way. This position is not essentially absurd, and Lord Avebury's arguments, loose and inconclusive as they are in many cases, will not affect it.

On the other hand, no tariff reformer can afford to neglect Prof. Smart's argument. It would not have been surprising if, after fifty years' almost unquestioned acceptance in Great Britain of the principle of free trade, those to whom it had become axiomatic had been found unprepared to meet a sudden attack from new quarters, and with quite unusual weapons. It would be idle to deny that the attack has been sharp, that the defenders have learnt much, and that economic science has benefited by the examination, revision, and modification of its doctrines. No one can now speak on the subject of foreign trade or tariffs without a careful analysis of the possible effects of the sudden changes artificially introduced by the policy of foreign nations or of combined capitalists. Prof. Smart is one of those found ready to meet the attack, and tariff reformers will find it difficult to move him or the readers of his book except by the hard blows of rigid and convincing logic.

For future readers there is a delightful note in the preface that the book "was written during the universal discussion which accompanied and followed Mr. Chamberlain's propagandism of Preferential Tariffs, and Mr. Balfour's advocacy of Retaliation." It may be hoped that the implied prophecy will be fulfilled, and that the book may occupy a permanent place as the best statement of the case for free trade in 1904. Perhaps because Prof. Smart was "a Free Trade manufacturer in this country, and a Protected manufacturer in the United States," before he became a teacher, his writings are always marked by a simple practicalness as well as by lucid reasoning. There is an almost complete absence of the use of technical terms, but without them it is found possible to disrobe arguments in favour of this or that modification of freedom of trade of their speciousness, and to show exactly in what circumstances they are true. Prof. Smart finds the most deeply rooted reason of the very general (foreign) approval of protection in the idea that "the continued existence of a nation, as a nation, depends on its finding employment for its own people." No proof has ever been offered either from theory or statistics that protection regularises the demand for labour, whether permanently by stereotyping an existing division of labour, or temporarily by diminishing the amplitude of the fluctuations related to the periodic ebb and flow of commercial credit. It is true that when an industry is well established, capital invested and labour specialised, much temporary loss may ensue if a sudden artificial diversion of the channels of trade is made, and it often appears that this might be met by protection; and it is certain that a sudden removal of protective barriers, already existing, would be disastrous. Backed by such reasoning, there is always a strong minority in favour of protection, just as there used to be strenuous opposition to the introduction of machinery, while the uncombined majority of consumers is often mute. This line of argument at best supplies a case for specific and temporary protection, and is completely dealt with by Prof. Smart when he shows that as a matter of history it has not proved possible to restrict protection to any point that economic science might assign.

"When a Government once adopts the protectionist faith, it is driven by force of circumstances, not to select and categorise, but to tax everything; and when it tries to let in some things free, or at a reduced rate, is met with a storm of opposition from hundreds of vested interests."

Without assenting to or denying the plea that protection can be advantageous in some cases, it is shown that practically vested interests are established, and that science gives way to political exigencies, a condition in which the pushful and unscrupulous succeed better than the deserving.

The treatment of the possibility and use of retaliation is marked by similar appreciation of the reasons alleged in its favour, and practical examination of its difficulties in detail. In the absence of any specific proposals, it is always open to a retaliator to say that the plans analysed are not the ones in question, but most of the possible cases are considered, and the special difficulties in England's way are shown.

"So far as I can see, the only part of Retaliation for which we are prepared is the threat of it. So great is the power of the British Lion's roar that it even seems enough to show that he is opening his mouth ominously. Suppose the other beasts of the forest do not fall down and creep to his feet, what then? Would it not be better to change his mind? It will scarcely be dignified to pretend that he was only going to yawn."

Prof. Smart admits the possibility of dumping, but considers that its extent is much exaggerated, that in the nature of things it is temporary, and that there is no practical remedy. The reader is left with the impression that a remedy would not be refused on any pedantic grounds if a strong case were made out. The absence of pedantry, and the broadness of view which marks the whole book should make it at the same time of great service to the hot-headed free trader, and a not disagreeable corrective to the tariff reformer who is not too sure of his ground.

A. L. B.

PLACE-NAMES OF SCOTLAND.

Place-names of Scotland. By James B. Johnston, B.D. Second edition. Pp. cxi+308. (Edinburgh: David Douglas, 1903.) Price 6*s.* net.

THE author of this work aims to do for Scotland what Dr. Joyce in his "Irish Names and Places" has already done for Ireland. It is a laudable attempt and one that is full of interest. Not only do we get here an alphabetical list of a large number of the place-names of Scotland, with explanations of their origin, but introductory chapters dealing at some length with the different sources from which have sprung the characteristic names of North Britain. Thus Mr. Johnston gives an account of the Celtic, Norse, English, Roman, Norman, modern, and ecclesiastical names, aiming to make his treatment of the subject no mere dilettante trifling, but a work based on historic evidence. He has in many cases ransacked old books and documents to get the older forms of the words as a guide to their original meaning, and this is really the most valuable part of the task he has undertaken. Had he consistently followed out his own principles enunciated in the introduction, his work would have been of a much higher order and free from the defects which too obviously encumber it. As it is, many of his derivations are quite as fantastic as the "mouth-esk-burgh" for Musselburgh, which by the laws of phonetics he solemnly rejects.

The real reason for the inequalities which even a second edition of the book, after twelve years' interval, has failed to remove is the author's inadequate acquaintance with the Gaelic language. As he admits himself, the Celtic names constitute the largest and most complicated portion of his task.

"The Celt's warm, emotional heart loved to seek out the poetry and colour in the world around, and many of his place-names show that 'stern nature was his daily companion, and friend.' Indeed, the majority of Celtic names give either the simplest possible description of the site named, or describe some prominent feature, or else the colouring or appearance of it as it strikes the eye."

In view of this, it is obvious that a thorough knowledge of the original language spoken in the country, as well as of the topography, is essential to the writer who would adequately discuss the meaning of the place-names; without it there must necessarily be much juggling with words.

If Mr. Johnston really knew the Celtic laws of aspiration and eclipsis, he would never say that the Gael loves to speak of the "Shawms of David," nor would he, when deriving Nairn from G. an earrann, find it necessary to suppose that Auchenairn must be Auchencairn through loss of c. Clachnaharry is clach na h'aire, "stone of watching," and yet he cannot think what Altnaharra is unless allt-na-charraigh, "stream with the pillar or rock," or from marbhaidh, "of the slaughter."

Allt, which is a streamlet passing through a ravine, he interprets sometimes as a glen or river. Kil, so common in the place-names of Scotland, becomes at one time cill, church, at another caol, narrow, again cul, back, and yet again coille, a wood, in the most arbitrary fashion. Auchter suffers in the same way, being uachdar or achadh just as suits his fancy. Take the three words ending in ellan. Killellan, we are told, is "church of St. Fillan," Inellan, en eilean, "bird-island," Balmaclellan, "village of John Maclellan." On the same principle Balmaghie becomes in this book "village of Macghie," whereas it more probably means "wind-swept town," like Tonderghie, not far away from it, which means "back to the wind." Another form of the word, Balmuchie, ludicrously appears as "the house or farm of swine." Banavie, he says, is probably not the "Vicus Bannavern" of St. Patrick's birth; why *probably* in a matter so entirely certain by every form of evidence?

Mr. Johnston says "every 'ness' is Norse, this being the Icel. nes, Dan. Naes, a nose," and he admits that it may be traced in names like Stromness and Deerness. Yet when he comes to Alness he has recourse to the extraordinary derivation G. ath'n-innis, "ford of the island" (the Black Isle). It would indeed take as violent a stretch of imagination to suppose that the Cromarty Firth was fordable at Alness as to imagine that Rogart means "red enclosure," "from the Old Red Sandstone here." As a matter of fact there is no Old Red Sandstone there, only granite. But these derivations are no less ingenious and far-fetched than that for Belleville, near Kingussie, which in a footnote Mr. Johnston says is in G. bail-a-bhile (*sic*), "village at the brae-top." Who with any claim to Celtic literary knowledge does not know that Belleville is the name which James Macpherson of Ossianic fame gave to the house which he built in the eighteenth century, thus superseding the former name of the place, which was called Raitts? No Highlander would translate allt grad as "*ugly* burn," or write achadh *tu*as for "field above" as the derivation of Auchtose. Ptolemy in his ancient map did not apply the name Varar, as here alleged, to the Moray Firth, but to the estuary of the Farrar, now the Beauly.

Many of the most beautiful ancient names in the country, such as the names of farms, little hills, lochs and rivulets, as well as hundreds of names beginning with prefixes such as tigh, allt'tobar, Ceann, Cnoc, &c., are left wholly untouched. One wonders on what principle the author selects some of the names he inserts and omits others. There are not more than about 500 names worthy of note in his own county of Stirling, he says. Why! there are almost as many in many a parish.

Yet for all its defects Mr. Johnston has written a book which is a good foundation for a better, and will have a fascination for a great many people, and it is quite true, as he says, that the historian, the philologist, the antiquarian, and the anthropologist will, each and all, find in it sidelights both helpful and interesting.

AN IMPRESSIONIST TEXT-BOOK OF PAPER MAKING.

Chapters on Papermaking. Vol. i. By Clayton Beadle. Pp. 151. (London: H. H. Grattan, 1904.)

THERE is a "mission" for science in relation to industry which is to re-infuse into its reiterated routine operations that measure or kind of interest which we know as "intelligent." Our factory workers are not the craftsmen of the past centuries; division of labour makes this difficult, and in many cases impossible. But though shut out from the "joy" of the craftsman, and far removed from that higher order of appreciation which makes the craft of the Oriental a part of his religion, our workers can cultivate an intelligent interest in their work. The book before us is directed to this particular aim, and is especially justified in regard to the art of papermaking, not only because modern papermaking is in all essential respects based on the ancient craft, but the various operations are interdependent on such obvious lines that whatever particular section of the work a man may be engaged in, he can easily acquire and keep an intelligent grasp of the whole.

The book may be described as a series of studies of special points, largely and evidently such special points as have from time to time challenged the interest of the author in the course of his occupation as chemist to one of our oldest and most important paper mills. There is no essentially logical sequence in these studies, but we agree with the author that there is no occasion to multiply routine text-books. It is obvious, therefore, that there is no call to read the chapters in any particular order. The subjects treated may be briefly summarised as follows:—Raw fibrous materials and cellulose; bleaching and general view of the chemistry of the operations; the whole question of the function of water in relation to the manufacturing operations, as well as the physical and chemical points involved in the relation of water to the celluloses; paper in relation to the entire range of its applications, and the destructive agencies which it is required to resist and survive.

In dealing with these subjects the author follows the original method, that is, he develops his theme largely by original observations and investigations, trusting to the particular perspective of his own experience to give the subject-matter its cohesion. The result is quite satisfactory. There is room for contributions of this kind.

As a particular illustration of the author's methods, we may mention the statistical discussion on pp. 90–93 of the total contribution of basic matters in working-up a rag pulp, both engine sized (resin) and tub sized (gelatin and soap), in relation to the sulphate of alumina required to be used. This subject might be very much extended to involve many of the most interesting developments of modern chemical science, *e.g.* the ionisation of salts and the peculiar functions of the organic colloids in relation to electrolytes in solution. There is no doubt that the reactions in the beater will not be understood until studied in relation to these questions.

In a discussion of the theory of the bleaching process, the author returns to some questions arising in the study of one of the systems of electrolytic bleaching, which was based upon the circulation continuously of the electrolysed ($MgCl_2$) solution between the electrolyser and the potcher. There is no doubt that this condition gives an unexpected maximum of bleaching efficiency, possibly because energy may be carried in some particular forms not necessarily expressed in the simple oxidising actions of the solution, as, *e.g.*, on HI or As_2O_3. In this connection it is to be noted that Brunck advances a similar hypothesis in relation to ozone and its oxidising reactions (*Zeitsch. angew. Chem.*, 1903, p. 894).

Further, according to the specification of recent patents (Schuckert), the addition of certain organic compounds, more particularly resin (soda resinate), to a solution of an alkali chloride to be electrolysed enables a very much higher concentration of "bleaching chlorine" to be economically worked. Certainly there are points here which should attract investigators to a re-examination of the phenomena.

On the general question of bleaching actions, the author is somewhat discursive, and there are one or two inaccuracies and omissions in small but not less essential points. Thus, on p. 90, the reaction of sodium sulphite as an "antichlor" is stated to add to the alkalinity of the pulp. The normal sulphites in oxidising to the normal sulphates do not affect the balance of alkalinity. In cases where potassium iodide is decomposed by a paper, *i.e.* by a constituent of the paper, with liberation of iodine, the methods of Wurster should certainly have been imported into the investigation. The investigations of Russell should have been noticed, and the subject connected with the general question of autoxidation.

We mention such points to show that the methods of the author are suggestive rather than exhaustive, and paper mill chemists especially will find these lectures full of matter to set them thinking, observing, and in turn investigating a number of phenomena which they might otherwise neglect or pass over.

We apply in conclusion the text which opened this brief review:—There is the human side even to the highly competitive production of modern times, and authors who contribute to this aspect of industry, and notably to the pleasure of the worker, are deserving of the particular encouragement of a large circulation.

THE DEVELOPMENT OF THE HUMAN BRAIN.

Die Entwicklung des menschlichen Gehirns wahrend der ersten Monate. Untersuchungsergebnisse von Wilhelm His. Pp. iv+176. (Leipzig: S. Herzel, 1904.) Price 12 marks.

THIS work, as its title indicates, deals with the development of the human brain during the first four months. Half of the book, on the development of the cerebral hemispheres and the origin of the intramedullary tracts, is original matter, and continues the work already commenced in 1890 by the author's paper on the organisation of the medulla. The re-

maining half of the book deals with the early histogenesis of the nervous system, and is practically a recapitulation of the author's previous results, all, however, carefully re-studied in the light of additional material, and copiously illustrated with original photographs.

Apart from its scientific value, for which, indeed, the author's name is a sufficient guarantee, the book is a striking testimony to the debt neurology owes the late Prof. His, for not only is the entire work, comprising practically all that is known of the development of the human brain, based on the author's own observations, but most of the facts here described owe their first explanation to Prof. His.

In the introduction, the author briefly describes his methods, chief of which is his "graphic reconstruction," originally described by him in 1880, the only difference being that photographs of serial sections are now used instead of drawings. Following this is a tabular statement of the embryos used, and a discussion of the difficulties of age estimation, and the introduction closes with an earnest appeal for systematic measurements of all prematurely born embryos at gynæcological institutions.

The first portion of the book deals with the development up to the close of the first month, and commences with an account of the author's myelospongium, which, in opposition to Koelliker, he believed to be a syncytial network formed by the union of outgrowths from the spongioblast cells.

The author originally held that connective tissue cells took part in the formation of the definitive neuroglia, and especially that this was the mode of origin of Deiter's cells; in the present work, however, he agrees with the majority of neurologists that the original neural plate is alone concerned in the formation of the supporting tissue.

The author's "Keimzellen," as he showed in 1891, form both nerve cells and glia cells, and, as Schaper maintained in 1897, they are merely undifferentiated cells of the myelospongium in active multiplication, not, as the author originally supposed, a special form of cell to be distinguished from all other cell-elements in the neural plate.

The author gives a brief criticism of recent papers in opposition to the neurone conception, on behalf of which, it will be remembered, Prof. His was one of the first advocates; in particular he deals with Bethe's paper of 1903, in which the nerve is made to arise from a linear syncytial cell series which also later forms Schwann's sheath; His shows that Bethe is really dealing with the mesenchymatous sheath, which in the lower vertebrates, *i.e.* chick, appears very early; in man, as His's photographs clearly show, there is no possibility of confusing the growing end of the non-medullated nerve bundle with the surrounding tissue, and especially is this the case with Meynert's "fremdartiger" strands, as these grow into regions of the myelospongium practically free from cells. This portion of the book closes with a full description of the neural tube of an embryo at the end of the fourth week, "Embryo N" already described in previous papers.

The second portion of the book deals with the development of the cerebral hemispheres, and commences with a description of the author's well-known models; this is followed by a detailed account of the histogenetic differentiation of the hemispheres up to the close of the first month, and is illustrated by numerous exceedingly clear photomicrographs. A few pages follow on the blood vessels of the fore-brain. The last twenty-five pages deal with the origin of the intramedullary tracts.

The whole book is written expressly for the professed neurologist, and abounds in tabular statements, references to individual embryos, and so forth; but there is much, especially in the earlier parts of the book, which is also of interest to the student of general morphology, and it is on behalf of such students that we could wish the numerous excellent photographs of brain sections had been provided with reference letters.

No bibliography accompanies the book, a want duly apologised for in the preface. It should also be noted that, as indicated above, the whole development of the brain is not dealt with; in the author's words,

> "Ich theile mit, was mir mehr oder minder abgeschlossen vorliegt. Die Zwischenkapitel hoffe Ich, falls mir Leben und Arbeitskraft bleiben, in absehbarer Zeit zu können."

All zoologists will regret that this hope is not destined to be fulfilled. G. C. C.

THE TURBELLARIA AS PARASITES AND PARASITE-CARRIERS.

Die Turbellarien als Parasiten und Wirte. By L. von Graff. Pp. vi+65. (Graz: Leuschner und Lubensky's Universitäts-Buchhandlung, 1903.) Price 14.50 marks.

PROF. VON GRAFF'S latest work dealing with the Turbellaria is no less interesting than any of its predecessors, and students of parasitology must stand greatly indebted to him for putting together in such an accessible and stimulating form a full summary of all that is at present known of parasitism amongst the Turbellaria. The first half of the work is devoted to an account of the anatomy of six species of parasitic rhabdocœls. Although all of these have been previously described by von Graff himself, or by other writers, the ampler accounts here given clear up many doubtful points and supply precise information not hitherto available on various anatomical features. This part of the work is illustrated with three plates of great excellence.

The second part is devoted to considerations of a more general character. It includes a list of all known Turbellaria which have adopted a parasitic or commensal habit Amongst them von Graff distinguishes four principal grades of parasitism, namely, (1) occasional commensalism; (2) ectoparasitism; (3) occupation of some chamber in the body of the host which communicates with the exterior; and (4) endoparasitism. The author points out that the effects of parasitism of the second and third grades do not pro-

duce any very marked results on the parasite. The development of organs of adhesion is not greater than in the free-living species. Eyes may or may not be present, and the size of the pharynx varies with the species. The character shared by the largest number of representatives of these groups appears to be the loss of cilia, especially on the dorsal surface. There is hardly an indication of that increase in size of the genital glands so conspicuous in endoparasitic forms where the eyes and adhesive organs are frequently absent, the pharynx and nervous system much reduced, whilst the body, on the other hand, is invariably completely ciliated. As might be expected, the number of families represented in grades (2) and (3) is greater than the number of those which contain endoparasites; the majority of the latter belong to the Vorticidæ. The hosts most affected by parasitic Turbellaria are holothurians, crustacea, and mollusca. Other echinoderms, worms, tunicates, and vertebrates are also preyed upon to a lesser extent.

Von Graff makes some interesting comments on the classification of the platyhelminthes. The species of the genus Temnocephala usually regarded as transitional forms between the Turbellaria and monogenetic trematodes might, he points out, be referred with equal justice to the vorticid genus Derostoma. Again, Fecampia, when sexually ripe, agrees in characters of systematic importance with the cestodes. In fact, "the more thorough our knowledge of the platyhelminthes becomes, the more difficult it is to define the classes of the phylum. But just as so-called bad species are of value to the student of evolution, so these 'bad classes' of the flat-worms supply him with arguments which are the more convincing in that they rest on the sure ground of ascertained morphological facts."

The work concludes with a useful list of the very numerous parasites with which the Turbellaria themselves may be infected. These range from symbiotic algæ and bacteria to trematodes and nematodes. It is curious that the first recorded orthonectid, found by Keferstein in *Leptoplana tremellaris* thirty-five years ago, has not yet been adequately described. It differs considerably from the other orthonectids noticed since then.

F. F. LAIDLAW.

OUR BOOK SHELF.

Applications of the Kinetic Theory to Gases, Vapours, and Solutions. By W. P. Boynton, Ph.D. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1904.) Price 7s. net.

THERE are probably few mathematicians who can follow the long and difficult investigations by which it has been attempted to dispense with the second law, and to represent thermodynamical properties of matter as the changes which must necessarily take place in a molecular system for which the principles of dynamics and the laws of probability are assumed to hold good. Such attempts have been found practically in every case to involve some *further* assumption, whenever a kinetic theory has been applied to the consideration of irreversible phenomena, and Mr. Burbury has unearthed this inevitable assumption when it has escaped the attention of writers of several recent papers. It is probably as impossible to build up an irreversible thermodynamical system out of reversible dynamical elements without any assumption as it is to build up a Euclidean geometry without some axiom of parallels.

But apart from such considerations as this, a kinetic theory is of considerable use to the ordinary physicist in furnishing him with a mechanical representation of the properties of matter in its various states. Dr. Boynton has taken as his standard the requirements of a reader who is familiar with the elements of the calculus, and he has produced a book which will be of great value to students both of physics and of chemistry.

It is perhaps unfortunate that those English physicists who are most competent to write books like the present one are usually too much tied down by other duties to undertake such work, especially as the task is in most instances an unprofitable one to the author. It is therefore satisfactory to find that Dr. Boynton's book is written so much on the lines of an English text-book that it seems well suited for introduction into this country. The features which we particularly like are, firstly, that the author is careful to give his readers no excuse for believing he has proved a result when he has only given an elementary investigation of it, and secondly, that instead of introducing irrelevant philosophical digressions or views of his own, he has kept strictly to an exposition of commonly accepted theories.

It is much to be wished that the same could be said of all the books which find their way into our class-rooms from the other side of the water. It is because they do not generally come up to the present standard of excellence that the difficulty of writing English text-books that are worth writing is to be regretted.

G. H. B.

Handbuch der Physik. By Dr. A. Winkelmann. Second Edition. First part of vol. iv., Electricity and Magnetism. 140 figures. Price 12 marks. First part of vol. vi., Optics. 170 figures. Price 14 marks. (Leipzig: Barth, 1904.)

EVERY student of physics will share the satisfaction of the editor of this treatise that a second edition was called for so soon; for he has found it to be an indispensable storehouse of expert knowledge in all branches of the subject, and the need for another edition enables it to be brought once more abreast of the rapidly advancing tide of knowledge.

The book is of the nature of an encyclopædia, for each section is written by an expert in the section; twenty-two of the leading physicists of Germany collaborate in this way with Dr. Winkelmann, the editor, in its production. Of the two parts before us, that on electricity and magnetism is contributed by Drs. Graetz and Auerbach, while the part on optics is the work of Drs. Czapski, von Rohr, and Eppenstein.

References are brought up to the middle of 1902. Thus amongst electrical instruments the Dolezalek electrometer finds a place; the large amount of recent work on the properties of dielectrics is very amply discussed, including the double-refracting properties for electric waves. Great stress is laid on the important advances made in the construction and standardisation of standard cells.

The optical portion is wholly occupied with geometric optics and applications to optical instruments. The fact that the writers are connected with the firm of Zeiss is a sufficient guarantee of the quality of their contributions. The only regret that one feels in glancing through the book is that the tremendous

amount of material to be dealt with makes compression a *sine qua non*. It is only a taste we get; but the voluminous references to original sources forming the extensive footnotes point the way to a fuller feast. It is as a reference book that the chief value of the volume will be found; it is not intended for consecutive reading.

Each paragraph is a highly condensed account of a particular part of the subject. Thus von Rohr concentrates into a few pages the principal facts treated at more adequate length in his treatise on photographic objectives.

Again, von Seidel's method for dealing with the aberrations of lenses is limited to what seems very scanty treatment when the importance of the method is taken into consideration. But for fuller information the author is obliged to refer to a forthcoming work by A. König and himself—there is only room for outlines in a work like the present.

The work throughout is produced with the thoroughness which is characteristic of German publications. We look forward to the completion of the entire book.

Laboratory Exercises in Physical Chemistry. By Frederick H. Getman. Pp. viii+241. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 8s. 6d. net.

THE title of this book might lead one to expect that what is really a distinct want had at length been met. Beyond the title, however, there is little in it that merits favourable comment; both in conception and in execution it is most inadequate. One finds, for example, that viscosity and surface-tension are accorded fourteen pages, of which four are purely theoretical and wholly out of place, whilst solubility is disposed of in four and a half pages. Again, we discover molecular volume in the chapter on thermometry, and polarimetry in the chapter entitled "The Spectroscope"! Not only is the author hopelessly deficient in the general sense of proportion and arrangement, but in matters of detail he is equally at fault. He actually (p. 30) introduces the temperature correction of the barometer into the calculation of a vapour density by Victor Meyer's method—the only method given—and does not even succeed in doing it correctly. He defines the unit of resistance as the international ohm (p. 153), and then gives his data in terms of the Siemens mercury unit (p. 172), which is never defined or even mentioned. Turning to his practical instructions we encounter the same thoughtlessness and omission of important details. The student who carried out a series of conductivity measurements at different dilutions according to the instructions on p. 177, for example, would obtain truly wonderful results, for no mention is made of the necessity of having two pipettes so adjusted that one withdraws exactly the same volume as the other delivers. What, again, is a student to make of the instruction on p. 178—"About 20 c.c. of a N/32 solution of pure sodium hydroxide is titrated with the dry acid of which the basicity is sought"? These instances suffice.

In closing the volume one can only express the hope that there may speedily be forthcoming a book which shall be in fact what this is in pretension.

Les Animaux domestiques. By J. Anglais. Pp. 103; illustrated. (Paris: Schleicher Frères et Cie., 1904.)

THE object of this volume may be best described by paraphrasing the first portion of the introduction, where Dr. Anglais states that it has been his aim, with the aid of a number of ingeniously planned coloured plates, to describe the essential characteristics, both external and internal, of a certain limited number of types of our most familiar domesticated animals. It is addressed to all who desire to make themselves acquainted with the leading features and characteristics of such animals, without the drudgery of long and profound practical study, and to acquire a general idea of their physiology and the history and object of their subjugation by man. As many details as possible of the peculiarities of the external form and of the internal anatomy are displayed in the illustrations and described in the text, so that it is hoped the work will serve in the case of some readers as an epitome of comparative anatomy and morphology, while for others it may form a starting point for more detailed study. The animals selected for illustration are the horse, the cow, the sheep, the pig, the dog, the cock, and the goose, each being illustrated and described on the same plan.

The illustrations of each species are five in number, and are printed on both sides of the cards, which are cut out to the shape of the animal, and so arranged as to fold over one another. The first shows the external form, the second the skeleton, the third the vascular system, the fourth the muscles, and the fifth the nervous system and viscera.

So far as anatomy can be learnt by means of diagrams, the work appears to deserve all that is claimed for it, and it will probably prove of considerable assistance to artists. Whether all the subjects selected for illustration would meet with commendation at the hands of breeders may, perhaps, be open to question. R. L.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Traction of Carriages.

IN tentative answer to your correspondent, p. 270, I suggest the following:—

The best angle of traction on a rough or irregular surface is at an upward inclination to its general slope. This upward slanting pull can be applied to a two-wheeled vehicle, and to the fore-wheels of any vehicle, but not to the hind wheels—especially if they are far away.

Consider, further, the summit of a hill, and let a waggon be so elongated that its hind wheels are still ascending while the horse is descending: his pull is exerted at a very bad angle on this part of the load, and in extreme cases the hill might almost act as a detent.

I should like to take the opportunity of saying that whether the traditional heavy draught of a long-bodied carriage is well founded or not, I am convinced that the ordinary hanson cab is badly balanced, and that a horse would be better with some load on his back, except when descending a hill. The comfort of a wheelbarrow over a balanced cart is considerable.

Though it may be easy to overdo the loading, nothing can be worse than a constant upward pressure on the chest of a horse: a pressure which at present automatically increases on an up grade, thus tending to deprive the animal of part of his own weight, on the existence of which the efficacy of every locomotive depends.

OLIVER LODGE.

Lobster Hatching.

PERHAPS your readers interested in economic marine biology may care to know, as a small contribution to the record of times and seasons, that the berried-lobsters kept at the Port Erin Biological Station started hatching out their young on July 15. So far the loss after hatching has been under 1 per cent. We find the best food for the young lobsters to be finely teased up fresh liver of the common shore crabs. W. A. HERDMAN.

Biological Station, Port Erin, Isle of Man, July 22.

THE PRESENT STATE OF AGRICULTURAL EDUCATION IN ENGLAND.

WE have just received from the Essex Education Committee a little illustrated pamphlet which tells us what is being done in that county for the education of the agricultural community. It represents a different system from any prevailing elsewhere, hence it may be worth while to examine it not only on its own account, but from the more general point of view of the organisation of rural education, so great is the diversity of procedure in the various counties.

The centre of the Essex system is a set of laboratories, chemical and botanical, in Chelmsford; here samples of manure, foods, soils, seeds, &c., are tested for the local farmers; here also various investigations in connection with the field experiments or with special problems arising in the agriculture of the county are carried out. The laboratories form primarily an investigating and advisory centre; at the same time a considerable amount of direct instruction is given there, mainly in the form of short courses for adult students. There is a winter school of agriculture giving a nine weeks' course, shorter courses still in horticulture and dairying, Saturday classes for the instruction of elementary schoolmasters, and a series of occasional lectures on market days for farmers. From this centre also emanate the lecture courses given in the winter up and down the county.

Of course, this does not exhaust all the work being done in this direction by the Essex County Council; at Dunmow there is an intermediate school with a strong agricultural side, and at one end of the scale there are scholarships to be won at Cambridge, at the other classes in such manual operations as ploughing, shepherding, farriery, &c. On the whole, then, the Essex farmer is not badly served; he has a scientific organisation working out the local problems which he can consult for technical advice, and a recognised system of education by short courses is being developed for him, though as yet it is in a somewhat imperfect state.

But it is noteworthy that neither the Board of Agriculture, which has charge of all higher education in agriculture, nor the Board of Education can even advise, much less control; the whole scheme is managed by a committee "which, with the single exception of the Chairman, consists entirely of Essex farmers." All honour to such a committee for the open-minded way it has attacked the problem, but in the end so restricted an administration cannot make for efficiency.

The county unit for educational purposes is valuable, always provided the central authority is active to coordinate, to give continuity of policy, to prevent, on the one hand, overlapping agencies, and on the other to see that the whole field is covered. It would be easy to point out the weak spots in the Essex programme, the scanty provision for secondary and the neglect of primary instruction of a rural character, but the county authority is working hard according to its lights and to its resources. Turn to the neighbouring counties, and the need of some central stimulus is seen; Herts does about as little as it can, a few lectures and some courses on cottage gardening represent its method of shelving its duties, while in Suffolk we are informed that part at least of the technical instruction money goes in 5*l.* doles to village flower shows! These counties and many others like them have but slender funds to devote to technical education, so slender that it does not seem to be worth anyone's while, inside the county or out, to see that they are rationally spent. The only authority which has any power is the Local Government Board, the auditor of which has to see that the expenditure is on something that can be made to square with a definition of technical education!

The time has come when either the Board of Education or the Board of Agriculture (and it is also a pressing matter that one or other of these bodies is made wholly responsible for agricultural education) should step in and tell the county councils what they ought to do and how they must set about it. By this time experiments enough have been made, for it is well known what sort of work will succeed and what schemes are feasible; in one county or other every sort and grade of rural education has had a trial, and some survive to do excellent work of their kind. Only a central authority knows what has answered elsewhere and can be made to answer again; at present we see county after county embarking on schemes foredoomed to failure, schemes which each committee thinks to be new inventions instead of the obvious mistakes into which every beginner falls unless he has the forethought to get up his subject. The free experimenting of the last ten years has done its work; it is time now to apply the successful results. And unless the central authority does intervene in earnest, it is not too much to say that the purely rural counties will never get any agricultural education at all; they are poor and unenterprising, they are isolated and bitterly averse to cooperating with neighbouring counties as feeble as themselves (even east and west Sussex cannot join forces to support the same agricultural school), lastly, they are angry at being called upon to meet the unexpectedly heavy demands for elementary education, and will divert as much of the "whisky money" to that end as they can. It is not that the country is without agricultural education; we have now many organisations as good as anything in America or Germany, which have equally won the confidence of the farmers for whom they were designed. Among others, we need only instance the Kent and Surrey joint scheme which makes a centre of the Wye College, or the Cheshire School at Holmes Chapel, but whole tracts of the country that are even more in need of similar work are absolutely blank, and are likely to remain so unless a central authority can step in with some power and a determination to shake the self-complacency of the backward county councils.

From another point of view the lack of a central authority with a wide general outlook is even more disastrous—there is no provision for the furthering of research. Now it is not only a truism that any scientific teaching that is to be of value must be based on research, but anyone who has had experience in that line has learnt that you can only secure the sympathy and cooperation of farmers by instituting investigations in which they are interested. A course of lectures on agricultural chemistry would go unheeded, little more attention would be paid to a course on manures; but offer them the results of some first-hand experience in the shape of experiments dealing with a problem of local importance, and they will come to hear and remain to discuss. How does the American Department of Agriculture seek to commend itself to its farmers? Almost wholly by research. Principal Reichel's article, again, in the reports of the Mosely Commission, tells us how the great Canadian agricultural college at Guelph only took root when it got hold of the farmers by experiments followed by discussion. Yet the Local Government Board, which passes many curious things masquerading as education, draws the line at research, and even the Board of Agriculture, which has some money

to spend on furthering higher agricultural education, has decided that research is outside its purview.

Yet if there is one field of work of proved public utility which wants the fostering of a central authority it is agricultural research. To begin with, when it is only possible to raise one crop in a year the progress of an agricultural investigation is necessarily slow, and requires to be continued without any external pressure to produce a result quickly. Again, the problems of the nutrition of plant or animal are so complex that the investigator, eliminating variables to obtain a crucial test on some particular point, appears altogether unpractical to the farmer. Now that the main principles of the action of manures and their adaptation to particular crops and soils are known, original investigation, which is really breaking new ground, will not appeal either by its methods or even by its results to the ordinary man. It will be done for the benefit of the teacher and the expert, and will get translated into practice by modifying the instruction or advice which they give to the actual working farmer. But research of this kind will never obtain the support of the county councils, except so far as it is undertaken out of pure keenness by individuals on the staff of the various teaching institutions; the county councils require demonstrations of the application of known principles to local conditions and experiments for the enlightenment of the current generation of farmers. Even with such trials it is difficult to secure the necessary continuity of policy; Somerset has just discontinued its experimental farm after a very few years' trial, and there is a local movement directed against another county experimental farm which is very ominous in view of the pressure on educational funds brought about by the new Bill. For permanent investigations, "travaux à longue haleine," we have in this country only Rothamsted and the Royal Agricultural Society's station at Woburn; Rothamsted has but 2500*l.* a year (each American State gets at least 4000*l.* a year for its experiment station!), and is asking for further funds to enable it to do more than continue to exist, yet it does not appear to have convinced the Board of Agriculture that research is part of education or is worthy of assistance. As to the Woburn farm, who can say what will happen through the financial straits into which the society has been driven by its show at Park Royal? But in any case compare these two solitary agencies with the great organisation possessed by the United States, of which we get a personal impression in Prof. Armstrong's paper in the Mosely Commission reports. Yet it cannot be argued that we need such work any less than America, for even if in England itself "agriculture only stands for shillings where commerce stands for pounds," the proportion is very different when we look at the Empire as a whole. Teachers and investigators are being constantly called for; how are the experts to be trained, the teachers to be inspired, if there is no adequate provision for research at home? Up and down our dependencies men may be found doing expert work in agriculture, men whose knowledge, both of agriculture and of science, has been acquired by working as assistants in commercial analytical laboratories; these men are doing excellent work, but they cannot wholly escape from the defects of their training.

Nobody familiar with the facts can fail to recognise the enormous advance that has been made within the last twelve years, before which time agricultural education did not exist for the ordinary farmer; now it is good "in parts," and the time is ripe for a strong central administration to take the work in hand, level up all round, and put research, which should be the mainspring of the whole, on a sound independent footing.

TWO BOOKS ON LOCAL NATURAL HISTORY.[1]

MR. TREGARTHEN'S brightly written and exquisitely illustrated book is absolutely redolent of the breezy uplands and the surf-beaten beetling cliffs of the western duchy, and is evidently the work of a sportsman-naturalist of the old-fashioned and best type. It is true that the author deals with his subject more from the sporting than from the natural history aspect—and to a great extent with the methods of sport belonging to a bygone day—but perhaps it is none the worse for this, being entirely free from all traces of that "faddism" which tends to taint the work of many of the self-styled field-naturalists of to-day. Whether he is describing fox-hunting in the olden time, the habits and wiles of foxes and their cubs, dilating on the fascinations of digging out badgers from their subterranean retreats, or narrating the perils attendant on a midnight descent through a tortuous adit to the rocky cave where dwell the seals, he is equally delightful and fresh. All the photographs of animal life, to say nothing of those which portray the striking coast scenery of the Land's End district, are admirably well chosen and well executed, the one of fox cubs herewith reproduced being only a sample of the general excellence of style.

Although ostensibly devoted to sport, the work contains here and there some interesting observations with regard to the fauna of the county. We are told, for instance (p. 165), that hares are almost non-existent in this part of the country, their scarcity being due apparently not to excessive persecution, but to the unsuitableness of the climatic or other physical conditions. Some years ago, upwards of 150 of these animals were turned out in various parts with the result that within a comparatively short period nearly all had disappeared. It is satisfactory, however, to learn that the badger (why will the author call it one of the most ancient of animals?) is as abundant as the hare is scarce, the author stating that it generally shares a burrow with the fox. Seals, too, thanks to their wariness and the almost inaccessible caves they select for their abode, show no signs of decrease on the northern coast.

To the naturalist, the description of the seal-caves and their living denizens is, indeed, the cream of the whole book, and many readers would, we feel sure, long for an opportunity of beholding the scene described, were it not for the attendant dangers and difficulties. The particular visit described was made by night at low-water, when the entrance to the cave was barred by exposed boulders, thus rendering it impossible for the seals to escape. "We advanced to the edge of the water," writes the narrator when describing the visit, "with a torch in each hand, holding them well up, and forward at full arm's-length. It was the sight of a lifetime. Five huge beasts, two grey, the rest a dirty yellow, mottled with black spots, lay swaying on the sand, prepared to make a rush—they can shuffle down a slope at a great pace—if we entered the pool; and these were not all, for in dark recesses beyond I saw indistinct forms move, and once I thought I caught the gleam of liquid eyes."

The numerous species of sea and shore birds frequenting the Land's End claim the author's attention in the concluding chapter, where reference is also made to several of the rarer birds of the land. Both

[1] "Wild Life at the Land's End; Observations of the Habits and Haunt of the Fox, Badger, Otter, Seal, Hare, and of their Pursuers in Cornwall." By J. C. Tregarthen. Pp. xii+236; illustrated. (London: John Murray, 1904.) Price 10*s.* 6*d.* net.

"In the King's County." By E. K. Robinson. Pp. viii+352. (London Isbister and Co., 1904.) Price 6*s.*

magpies and green woodpeckers are stated to be more common at the present day than was formerly the case, while it is only of late years that the pushing starling has taken to breed in the district. With a bare reference to the account of the author's last sight of a pair of Cornish choughs—possibly the last of their kind—we must take leave of a charming volume.

In any work devoted to outdoor life in Norfolk the element of sport is certain to loom large, next to which birds will probably claim a considerable share of the author's attention, and Mr. Robinson's volume is no exception to this rule. Such subjects as "a royal shoot" and "beside the covert" are, indeed, intercalated with chapters on "panics in bird-land," "the hawk's harvest," and the "birds of autumn," and throughout the portions devoted to the wild life of the county there will be found scattered many observations which cannot fail to be of interest to the field-naturalist and lover of the country. A feature of the work is the candid and straightforward manner in which the utility or harmfulness of the mammals and birds generally classed by keepers as "vermin" are discussed, no special pleading being used to afford any of these creatures exemption from destruction when, in the author's opinion, it is well merited. Among the mammals which, according to Mr. Robinson, rightly occupy a place in the "keeper's museum" are the stoat and the hedgehog, the indictment against the latter, from the keeper's point of view, being even heavier than the one in Bell's "British Quadrupeds."

To residents in Norfolk the book should prove specially welcome, but it is also one which can be taken up to while away an idle hour by every reader interested in sport and country life. R. L.

FIG. 1.—Fox cubs. From Tregarthen's "Wild Life at the Land's End." *From a Photograph by C. Reid.*

RELATION OF RAINFALL TO RUN OFF.

IN NATURE of January 7 (vol. lxix. p. 226) notice was directed to the attention paid by the Geological Department of the United States to the water resources of the country, and to the series of reports that had been issued relating to the supply available for domestic and business purposes, for power and for irrigation. We have recently received a further series of reports relating to the progress of the stream measurements for the year 1902 carried out on the northern and southern Atlantic coasts, Mississippi River, Great Lakes, Pacific coast and Hudson Bay drainage districts; the hydrography of California and the storage reservoir there; and an account of the irrigation of India.

With the exception of the last, these volumes consist almost entirely of statistical records of the flow of streams, and although of great value to American hydrologists, do not call for any special notice.

Paper No. 80 of the series of hydrographic investigations on the relation of rainfall to run off, compiled by Mr. George W. Rafter, contains information which is of value to those interested generally in the question of water supply.

The author of the paper commences by saying that, as the result of many years' study of the problem indicated by the title of the paper, he has come to the conclusion that no general formula is likely to be found expressing accurately the relation of rainfall to the run off of streams, for these vary so widely in their behaviour that every stream is a law unto itself.

Mr. Rafter directs attention to the desirability of the adoption of uniformity or standardisation of the units of measurement, and warns engineers to be very slow to add to the number of standards of measure

for flowing water already in use. In the United States, as in this country, the cubic foot is taken as the unit of volume and the second as the unit of time when measuring flowing water in streams, while here the gallon is generally adopted as the unit when dealing with supplies for domestic purposes. In the United States the million gallons in twenty-four hours appears to be recognised as a standard for city water supply, and an acre in area covered one inch or a foot deep in a month or a year is used for irrigation purposes. The unit of inches of rainfall per acre on the catchment area and the resulting run off in gallons for town supplies, or in cubic feet for drainage, is a measure of very general adoption. In India many irrigation engineers have adopted the term "cusecs" as representing cubic feet per second.

With regard to the proportion of rainfall that finds its way into a stream, the author deprecates the use of averages, and expresses the opinion that safe deductions can only be obtained from using the minimum rainfall and taking into account the longest period such minimums may be expected to occupy. The records of the United States show that this minimum period may be expected frequently to last more than three years.

In this country the general rule is to take the average of the longest period over which the rainfall records of the district extend, from this to deduct one-fifth to allow for the mean annual rainfall of the three consecutive driest years, and from the product further to deduct from eleven to fifteen inches for loss by evaporation, soakage, &c., according to the character of the ground, the remainder giving the quantity available for storing. If compensation water has to be provided, a further deduction of one-third of the available supply has to be made. Fourteen inches is commonly taken as the figure representing evaporation, &c., in this country. For example, with an average annual rainfall of thirty inches, ten inches would be available for run off or storage, or, where compensation water has to be given, 6·67 inches would be available for storage. Taking an inch of rainfall as 3630 cubic feet per acre, 10 inches would give 36,300 cubic feet or 226,300 gallons to the acre of gathering ground.

As a general statement, Mr. Rafter's investigations have led him to the conclusion that the minimum rainfall varies from half to one-fourth the maximum.

The late Mr. Symons's proportion for this country was that the rainfall for the wettest year was half as much more than the mean, and for the driest year one-third less, or, taking the average of three wettest years, one-fifth less than this average.

Mr. Rafter considers that averages derived from a shorter period than thirty-five years are not to be relied on within 2 per cent. The same conclusion was arrived at by Mr. H. R. Binnie in his paper on the average annual rainfall reported in the minutes of proceedings of the Institution of Civil Engineers, 1892. This figure was derived from an examination of rainfall statistics from 153 stations situated all over the world. While short periods like five years' average gave an error of 32 per cent., and thirty years 5·8 per cent., the error for thirty-five year periods was only 2½ per cent., and fifty years came no closer.

Although the annual quantity of rainfall varies very much in different localities and in different countries, the same law universally applies as to the relation of the wettest and driest years to the average fall if taken over a sufficiently long period.

As pointed out by the author of the report, caution is necessary in taking the average of the rainfall as a guide; for storage purposes, where the water has to be collected in a reservoir a minimum fall derived from an average of years may be a trustworthy guide, but where provision has to be made for carrying off the water in artificial channels for drainage purposes, or where the water has to be pumped, as in low-lying districts, the data to be ascertained is the maximum rainfall that has to be dealt with in a short period. Thus, while the rainfall of the year, or even of the winter months, may not have been excessive, yet floods may have ensued due to heavy rain falling for a few days on ground already saturated. In the Fen districts on the east coast of England, which depend entirely on artificial drainage, the rule is to allow for a discharge equal to a continuous fall of a quarter of an inch of rain during twenty-four hours. The mean daily fall of the rain which caused the twenty-one floods in the Witham district since 1852 was an average of 0·26 inch spread over seventeen days; the average annual fall of the district for the wet period was 32·39 inches, and over a period of seventy years 22·93 inches. The greatest fall during this period averaged 0·41 inch spread over fourteen days, in November, 1885, and also in October, 1883, when there was considerable flooding.[1]

The figures given in this paper show that in the eastern States of America with a maximum rainfall of from 20 to 60 inches half the rainfall runs off, and that with a minimum fall from a fourth to a sixth. In the western States, with a fall of about 12 inches, the run off varies from half an inch to an inch.

The total run off of a stream depends very largely on the run off of the storage period. Usually about 0·75 to 0·85 of the total rainfall of this period runs off in the stream, while for the summer, or growing period, not more than about 0·1 of the rainfall appears, this small quantity being due to evaporation and absorption by vegetation. The total run off for the year depends very largely on whether or not the rainfall from December to May is large or small. Whether any given stream is low during the summer months or has then a well sustained flow will depend very largely on the rainfall of the month of May. When the May rainfall is heavy enough to produce full ground water, the flow is likely to be well sustained.

The extent of afforestation seems to have a considerable effect on the run off of streams, catchments with dense forests showing a larger run off for the same rainfall than those which are deforested.

THE ARAPAHO SUN DANCE.[2]

THE scientific value of the anthropological series of the *Publications* of the Field Columbian Museum, Chicago, has been sustained by the important memoir on the Arapaho sun dance by Dr. G. A. Dorsey, the energetic curator of the Department of Anthropology. Although only very recently published, the work bears the date of June, 1903, which will cause superfluous trouble to bibliographers. Dr. Dorsey witnessed the sun dance in 1901 and 1902, and he has taken great pains to give a clear and minute account of this eight-day ceremony. The description is illustrated with a great wealth of illustrations, there being no fewer than 135 plates, many of which contain two figures; it is probably safe to say that no ceremony has hitherto been so amply illustrated. It is also a matter of congratulation that the description is so detailed, as the significance of a ceremony can only be adequately realised when all the details of the events

1 "The Fens of South Lincolnshire" (Simpkin, Marshall and Co., Ltd.) "The Drainage of Fens and Lowlands" (Spon, Ltd.).

2 "The Arapaho Sun Dance; the Ceremony of the Offerings-lodge. By G. A. Dorsey. Field Columbian Museum, Anthropological Series. Vol. iv. (Chicago, U.S.A., June, 1903.)

are carefully recorded. We can heartily congratulate the author and the museum authorities on the publication of this authoritative memoir. More information would, however, be welcome as to the precise part taken by the several social groups of the Arapaho in this national festival, as this is usually an important element in social ritual. Apparently the ceremony may take place at any time, but it is generally during the winter. It is performed in compliance with a vow.

Many ceremonies are performed in connection with a Rabbit-tipi (or tent), which is erected on the first day, and the men who perform the rites are known as Rabbit-men; the origin of the name is due to a myth. On the second day a sweat-lodge is built, not only as a means of bodily purification, but because they want to be cleansed from former sins, evil desires, and to be protected from all kinds of plagues. Next, a bison should be caught and killed; now they have to content

FIG. 1.—The straight-pipe being smoked by the Sun Dance priests and dancers.

themselves with any old buffalo robe that is available, and this skin has to be painted. On the fourth day the centre-pole for the Offerings'-lodge is cut down by two women, and brought into the camp and erected in its midst with great ceremony; as this new lodge is being completed, final rites are held within the Rabbit-tipi. In this very large lodge is the altar, and here dancing takes place, which is at the present day of a simple character. Near midnight of the second and fourth days a remarkable symbolic ceremony takes place between the grandfather and wife of the Lodge-Maker. The former personifies the sun and the latter the moon, and the ceremony brings strength to the people and increase to the tribe. The sixth day is known as "Medicine Day"; the dancers have now fasted for about forty hours, and it is supposed that by this time their minds are in a proper condition to be susceptible to the influence of the sun, and they are exhorted to be of a reverent frame of mind. The rising sun is greeted with a dance. During this most important day of the series new chiefs are inaugurated and names changed. There is a considerable amount of evidence that in former times unbridled license prevailed throughout the camp on this night, which was taken advantage of by all, as it was considered one of the rites of the ceremony; in more recent years this has been entirely given up, but the occasion is utilised for courting. The seventh day commences and ends with sun dances, and then takes place the ceremony with the symbolic sun-wheel. The dancing is particularly fatiguing, and finally, in the ceremony witnessed by Dr. Dorsey, a great shout was sent up by all, for the ceremony had come to a happy termination without anyone falling by the way and without a mishap. This impressive exhibition of endurance and faith is termed "gambling against the Sun." It expresses on the part of each dancer his earnest prayer and effort to conquer, to survive, and to complete his three days' fast without falling, in spite of the opposition of the intense heat of the sun; to survive means to win benefit. Then follow the bathing and purification of the dancers.

On the last day of the sun dance ceremony there takes place the final dancing out to meet the sun; the method of advancing by degrees outside the lodge is a form of asking the Man-Above and the Grandfather to listen to their prayers; it also typifies the going after something which is good. A shaking of blankets which takes place may be regarded as a purification rite whereby sickness and sorrow are shaken off. The smoking of the straight-pipe (Fig. 1) at this time, on the part of all, which forms the final performance in the ceremony, is to the effect that all might follow a straight road, that all might be protected, and that the families of those who have fasted and taken part in the ceremony might be guarded from harm, inasmuch as they have performed the ceremony according to the orders of the Man-Above.

Before dispersal, parents, often accompanied by their children, enter the Offerings'-lodge, and after praying, tie on to the centre-pole the clothes discarded by their children during the year. One of these prayers is as follows:—"White Man-Above, my Father, here are the clothes of my child. I am going to deposit them. They are no longer good for my child. By doing this I ask you to watch over him from day to day and keep him from temptation. May he grow up to be a man, to understand your teachings which we have just gone through! I hope you will hear our prayer for my child."

A. C. HADDON.

THE UNGULATE MOLAR.[1]

IN the course of his attempt to solve the puzzle of the homologies of the cusps in the more complicated types of ungulate molars, the author of this bulky memoir takes the opportunity of directing attention to certain points with regard to mammalian dentition in general, and also comments on the exceeding intricacy and difficulty of several of the problems presented thereby. The solution of one difficulty, he observes, not unfrequently gives rise to a whole crop of fresh problems, and, paradoxical as it may seem, every increase in our knowledge serves only to reveal the depth of our ignorance.

With the enormous amount of variation displayed

[1] "Recherches de Morphologie phylogénétique sur les Molaires supérieures des Ongulés." By F. Ameghino. *An. Mus. Buenos Aires*, ser. 2, vol. iii. Pp. 541, figures.

by the molars of the numerous types of ungulates peculiar to the Tertiary formations of South America, Dr. Ameghino has almost a superfluity of material upon which to work. So vast, indeed, is his subject, that it would be impossible, within the limits of our space, to follow him in his survey from one type to another, or, indeed, to discuss his general conclusions, and I shall therefore confine myself to directing the attention of my readers to certain points of special interest in the author's work.

In the first place, it may be noted that Dr. Ameghino reiterates his opinion as to the falsity of the tritubercular theory of molar development, tritubercular molars, instead of being the primitive type, having been derived, on his view, from those with four or six cusps. Whether this opinion is in any way biased by the author's contention that the earlier Patagonian mammals are of Cretaceous age may be worth consideration.

Of greater importance is the support given by Dr. Ameghino to the view that the molar formula of the placental and marsupial carnivores is numerically identical, that is to say, that there are three true molars in both (when the full series is developed) instead of three in the one and four in the other. He consequently regards the replacing marsupial premolar as the third instead of the fourth, and the tooth behind it as a persistent milk-molar. The numerical identity

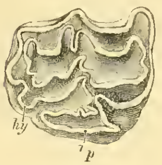


FIG. 1.—Right upper molar of horse. *p*, antero-internal pillar; *hy*, postero-internal pillar.

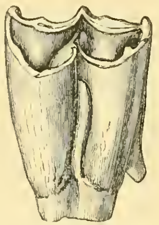


FIG. 2.—Left upper molar of Nilgai to show accessory pillar between the two main inner crescents.

of the marsupial and placental series was urged long ago by Prof. Gaudry, and this view was more fully developed a few years since by the present writer, when evidence in favour of the above-mentioned homology of the marsupial replacing tooth and the one behind it was likewise adduced. Although it has subsequently received the assent of Dr. Wortman, this view has not, however, yet been accepted by zoologists generally. It may be added that it is a question on which only those with a considerable amount of palæontological knowledge are competent to form an opinion.

Another point of great interest referred to in Dr. Ameghino's memoir is the alleged occurrence in Nesodon and certain other Patagonian Tertiary mammals of three distinct dentitions. Since the existence of this remarkable phenomenon is stated to have been accepted by Dr. Scott, it may apparently be taken as fully authentic. The "pre-lacteal" cheek-dentition, according to the figure given, consists of three very small teeth, differing somewhat in form from their successors of the milk-series. Dr. Ameghino, whose view is almost certainly in this instance influenced by his opinion as to the age of the Patagonian mammals, regards the "pre-lacteal" dentition as a direct inheritance from reptilian ancestors. In view, however, of the specialised characters of Nesodon and its allies, and the absence of a functional "pre-lacteal" series in any other mammals, it would seem much more probable that it is a superadded feature.

The last point to which we have space to allude relates to the homology of two of the cusps in the equine molar. To render this point clear, two figures have been introduced into this notice.

Since the date of publication of the first part of Gaudry's "Enchainements," the antero-pillar of the equine molar (*p* in Fig. 1) has been almost universally regarded as one of the primitive constituents of the tooth, corresponding to the inner extremity of the anterior transverse ridge (protocone) of the rhinoceros or anchitherium molar. From comparison with a large number of extinct forms, Dr. Ameghino comes, however, to the conclusion that this antero-internal pillar (which is detached in Hipparion but joined to the body of the tooth in Equus) is really a superadded element, derived from the cingulum, and corresponding to the "accessory pillar" of the molars of many ruminants (Fig. 2). Consequently, the protocone will be represented by a part of the anterior inner crescent of the horse's molar. Apparently Dr. Ameghino has made out a very strong, if not a conclusive, case for the new interpretation; I may add that the same opinion was independently arrived at and published by Dr. Forsyth-Major so long ago as 1873, but has been generally neglected in favour of the Gaudrian theory.

Without in any way endorsing all his views, it may be confidently stated that in this memoir Dr. Ameghino has made a very important contribution to mammalian odontology. R. L.

DR. ISAAC ROBERTS, F.R.S.

THERE is one class of scientific amateurs which seems to be the peculiar product of English society. Dealing with astronomy alone, and confining our attention to those who have passed away, we have such men as Lassell, Barclay, De La Rue, &c., all of whom, after amassing a considerable fortune in commercial pursuits, have devoted the evening of their lives to furthering the interests of their favourite science. The latest example of this earnest attachment to this particular branch of science was Dr. Isaac Roberts, whose death we record with profound regret. It is possible that he may be nearly the last of a distinguished series, for it is not unlikely that, as science tends to specialise in particular directions, such instances will become less and less frequent. The wealthy amateur, it may be, will continue to provide the means for others, but the requirements for the production of valuable work tend to become more and more severe, and the actual prosecution will soon be reserved to those who have been able to give up their whole life to special study. But Dr. Roberts was fortunate in finding a subject at which he could work with effect personally, and his own exertions were rewarded with valuable results.

For some years Dr. Roberts seems to have wavered between geology and astronomy as a congenial pursuit in his leisure hours. But possibly it was the application of some form of mechanical inquiry that attracted him in either direction. Among his early papers are the results of investigations affecting the circulation of underground water and the filtering and hygroscopic properties of Triassic sandstone. In studying the movements of underground waters, of which the observations were carried on with great regularity, he employed mechanical contrivances which he designed himself. Similarly, in practical questions such as the determination of the pressure of grain on the walls of lofty warehouses, when stored to great height, the mechanical side of the question seems to

have had the greatest attraction for him. Finally, when he settled down to the continuous study of astronomy and procured a powerful reflector suitable for his purpose, he introduced many small conveniences to assist the work, which no doubt contributed in a large measure to his ultimate success; for at the time he began his work astronomers had not recognised with the keenness they do now the necessity of controlled driving clocks to equatorials, and other happy suggestions for lightening the labour or the irksomeness of prolonged exposure in photographic work. This was the direction in which Dr. Roberts chose to work, and in which he earned a well merited reputation. It may be said of his early photographs that they were a revelation, and they are still worthy of profound study, though others working with more powerful instruments, and guided, it may be, by his early experience, have equalled and possibly surpassed them in the amount of detail shown. Two handsome volumes containing photographs of nebulæ and star clusters, which Dr. Roberts published at his own expense and widely distributed, speak to his industry and liberality, and his mechanical genius found another outlet by constructing a machine for the ready copying or transference of the positions of the stars photographed, to copper plates, from which they could be readily printed. How far this device has been used is uncertain; probably mechanical photographic processes have supplanted it.

Another feature in Dr. Roberts's methods which was eminently practical and worthy of imitation was the care he displayed in selecting a site for his observatory. His desire was to secure a good observing atmosphere and the greatest freedom from clouds, and many and minute were his inquiries, both at home and abroad, before he settled on Crowborough Hill, where his observatory was finally situated. Even shortly before his death he visited Las Palmas for the purpose of making some observations which required good observing conditions, and it will be to the regret of many friends that his activity and his energy are lost to us while he was still eager and capable of pursuing his favourite study.

The deceased astronomer, who had been elected a fellow of the Royal Society and many other learned bodies, was in his seventy-fifth year. He was twice married, on the second occasion to Miss Dorothea Klumpke, whose name and reputation are known throughout Europe, and to whom the deepest sympathy will be tendered.

NOTES.

We regret to have to record the death, at the age of eighty-two, of Sir John Simon, K.C.B., F.R.S., which took place on Saturday last.

The death is announced of Prof. Trasbot, formerly director of the Alfort School, at the age of seventy-two years. He had been a member of the Paris Academy of Medicine since 1886, and was the author of many works relating to pathology, epidemic diseases, and sanitary administration.

The death is announced also of Dr. J. Bell Hatcher, curator of vertebrate zoology at the Carnegie Museum, Pittsburg, at the age of forty-six years.

The Berlin correspondent of the *Lancet* states that Prof. Koch will vacate his position as chief of the Royal Institution for Infectious Diseases on October 1, in order that he may have more time for scientific research. He will, however, continue to be connected with the institution, and, by special order of the Government, will have on the premises a laboratory furnished at the public expense, and the clinical material of the institution will be placed at his disposal. We learn also from the same source that Prof. Koch is to succeed Prof. Virchow in the membership of the Royal Academy, Berlin, and that his successor as chief of the Institution for Infectious Diseases will be Prof. Gaffky, now of the University of Giessen. Prof. Gaffky's acceptance of Prof. Koch's chair in the University of Berlin was announced in our issue of July 14.

It is announced in *Science* that Mr. H. C. Russell, Government Astronomer of New South Wales, is to retire at the end of the present year, after forty-six years' service.

The seventy-second annual meeting of the British Medical Association was opened at Oxford on Tuesday last, when the president, Dr. Collier, delivered his address. In the evening a reception was held in the Sheldonian Theatre, and the Middlemore prize for the best original work on ophthalmology brought out during the past three years was awarded to Mr. J. Herbert Parsons.

The Lord Provost of Glasgow opened on Thursday last the health exhibition which has been organised in connection with the twenty-ninth autumn congress of the Sanitary Institute now in session at Glasgow. The exhibition is divided into colonial, municipal, and educational sections, and among the exhibits are a model hospital and a model one-house dwelling.

The congress of the Royal Institute of Public Health at Folkestone was opened on Thursday last and closed on Tuesday.

An intercolonial agricultural conference was opened in Pretoria on Monday last, and the delegates will discuss, among other subjects, the formation of a Central South African Agricultural Union, African coast fever, the native question, irrigation, and fruit and cotton growing.

The sixth centenary of the birth of Petrarch opened at Arezzo on July 20. The Count of Turin represented the King of Italy, and Signor Orlendo, Minister for Public Instruction, represented the Italian Government. An artistic tablet was unveiled at the house in the Via dell' Orto in which Petrarch was born, and later there was a memorial ceremony in the Politeama Aretino. The festivities lasted until July 25.

The new hall of the Royal Horticultural Society in Vincent Square, Westminster, was opened by His Majesty the King on Friday last. The building, which includes a library, offices, council chambers, and a lecture room, in addition to the large hall in which the society will hold its fortnightly exhibitions, has been built to celebrate the centenary of the society. In the address which Sir Trevor Lawrence read to the King and Queen the work of the Royal Horticultural Society was reviewed, and in regard to the efforts of the collectors sent out by the society in the nineteenth century, it was said, in the words of Mr. Andrew Murray, that "the results have affected the appearance of all England. Nowhere can a day's ride now be taken where the landscape is not beautified by some of the introductions of the Royal Horticultural Society." Perhaps nothing indicates more clearly the way in which the society has promoted the science and art of horticulture than the fact that whereas there were one thousand three hundred fellows in 1887, there are now eight thousand, one hundred and fifty. Baron Sir Henry Schroeder presented the report of the building and appeal committees, in which it was stated that twenty-six thousand pounds had been subscribed towards the cost of the hall, which will amount in the end to forty

thousand pounds. His Majesty received congratulatory addresses on behalf of the society. Dr. Maxwell Masters presented those from the Société Royale d'Agriculture et de Botanique de Gande and from the Horticultural Society of Prussia; Mr. Edwin Mawley that from the National Rose Society. His Majesty then declared the hall open. It is, we understand, the intention of the society to provide scientific instruction as well as practical training in connection with the gardens at Wisley.

Arrangements have been made which will make it unnecessary to close the Museum of Practical Geology, Jermyn Street, for a month in autumn as heretofore; the museum will therefore remain open to students and visitors daily.

The International Astronomical Congress will begin its meetings at Lund, Sweden, on September 5.

The tenth International Congress of Navigation is to be held at Milan from September 24 to 30, 1905. Applications for the local organising committee's letter of invitation to the congress, and for the programme of the arrangements made, should be addressed to the general secretary of the congress, Signor E. Sanjust di Teulada, 3 Via Sala, Milan, or to Prof. L. F. Vernon Harcourt, 6 Queen Anne's Gate, Westminster.

An interesting exhibition of about 700 incandescent electric lamps, including the first experimental lamps made by Mr. Edison, is about to take place at the St. Louis Exposition. The collection is stated to be complete and unique, and to include a specimen of every kind of filament lamp ever made in Europe or America.

According to the Indian correspondent of the *Lancet*, Mr. Tata left a will by which his heirs and trustees are required to carry out his intentions with reference to the research institute in which he took so great an interest.

The Paris Academy of Sciences has awarded the Lecomte prize of fifty thousand francs for the most interesting work in physical science to Prof. Blondlot for his researches on the *n*-rays.

A gold medal has been awarded to Commander Peary by the Société de Géographie, Paris, in recognition of his work in the North Polar regions.

The Elliott-Cresson medal is to be conferred on Dr. Hans Goldschmidt, of Essen (Ruhr), Germany, by the Franklin Institute, Philadelphia.

After an absence of a year and eight months the Scottish National Antarctic Expedition has returned to Scotland, leaving, however, Mr. R. C. Mossman, the meteorologist, in the South Orkney Islands to continue his research work. At the meeting held to welcome home the expedition, Sir John Murray, as president of the Royal Scottish Geographical Society, read the following message of congratulation which had been telegraphed to Mr. Bruce, the leader, by Lord Knollys:—"I am commanded by the King to congratulate you and the officers and crew of the *Scotia* on your and their safe return and on the completion of your addition to scientific knowledge and discovery in the south-eastern part of Weddell Sea.—Knollys." A number of other congratulatory messages were also read, the gold medal of the Royal Scottish Geographical Society was conferred on Mr. Bruce, and a gold watch-seal presented to Captain Robertson.

According to the *Electrical Review*, the United States Naval Wireless Telegraph Commission will shortly recommend the establishment of wireless telegraph stations at various strategical points on the sea coast. These stations will transmit all Government messages, including weather bureau information, and it is probable that commercial telegrams will also be accepted. The Treasury proposes to provide revenue cutters with wireless telegraph apparatus. It is also stated that a contract has been signed between the United States Government and the De Forrest Wireless Telegraph Co., by the terms of which it will ultimately be possible to send wireless messages between New York and Japan. The Government, which will defray the cost of the various equipments, will have the use of the various installations for naval and other purposes, and the company will be bound to maintain them in good working order with the right to transmit commercial messages.

We have received from the secretary a programme of the proceedings of the sixth International Zoological Congress to be held at Berne from August 14 to 19. Up to the present 250 persons have joined the congress, and a number of countries and scientific societies will be represented, while no less than seventy communications have been announced to be read at the various sections. These sections are six in number, and in them the study of geographical distribution is assigned an important position. The proceedings will commence by a meeting in the great market-hall on the evening of Sunday, August 14.

Mr. J. G. Millais is to be congratulated on his good fortune in having been able to add an entirely new mammal to the British fauna in the form of a vole (*Microtus orcadensis*), of which the description appears in the July number of the *Zoologist*. In a postscript by Mr. O. Thomas it is stated that the new species is totally distinct from all other known forms, differing from the common short-tailed field-mouse (*M. agrestis*) not only in external characters, but in the number of folds in the second molar, and being apparently equally distinct from the Continental field-mouse (*M. arvalis*) and the eastern *M. ratticeps* and their immediate relatives. It forms, in fact, a small zoological and geographical puzzle. In the same number Mr. R. J. Howard describes an instance of the long-eared owl nesting on the ground.

A note in the *Scientific American* directs attention to a communication which was recently addressed to the French National Society of Agriculture by M. Bignon on the efficacy of artificial clouds in preventing late frosts. M. Bignon has for many years successfully protected his vineyard by the method he describes. The vineyard is divided into five parts, separated from east to west by walks of from 12 to 15 feet wide, and is encircled by an avenue of equal width. These walks facilitate the placing of the fires, which are built in small basins sunk into the earth some 50 feet apart, and filled with 15 or 20 pounds of resinous matter and some pieces of pine and other vegetable débris. During 1903 (in one week of which the frosts were very heavy) the method saved, it is reported, 25 per cent. of the harvest, or some 125 to 150 barrels of wine. It is stated that any substance can be burnt which gives a thick and abundant smoke, such as green herbs, moss, damp straw, tufts of grass, &c., but best results have been obtained by the heavy oils which are the residues of gas.

M. Élisée Reclus is preparing for the Belgian Society of Astronomy, Meteorology and Physical Geography a monograph descriptive of the volcanoes of the world and maps showing their distribution. One map, in colours, will

be on a scale of 1 : 40,000,000, and this will be supplemented by others on a scale of 1 : 2,000,000. On the proposed maps all the areas the surface of which is formed of eruptive rocks will be shown, and the location of the various forms of volcanic phenomena will be marked. Volcanoes that are believed to have been extinct since the historic period, those that have been active since the beginning of human history, and those which have more recently been centres of eruption will all have their distinctive signs.

In the opinion of the town sanitary committee of St. Petersburg the town medical officers should be sent abroad periodically in order to become acquainted with the progress of the sanitary and medical departments of the large towns of western Europe, and so be able properly to organise medical and sanitary supervision.

Dr. R. Fulton, writing to us from Dunedin, New Zealand, suggests that polyandry among birds is connected with the parasitic habit of depositing the eggs in the nests of other species. After referring to the well known fact that the common cuckoo is very markedly polyandrous, Dr. Fulton proceeds to point out that the same feature exists, or is in course of being developed, among many other wholly or partially parasitic species, such as the American cow-birds and cuckoos, parasitism gradually creeping in *pari passu* with the development of parasitism. If our correspondent's theory is well founded, it would certainly seem worth the attention of ornithologists. The writer further states that, contrary to the usual opinion, there are numbers of instances known where cuckoos (species not stated) have supervised the forced adoption of their offspring by other species, have assisted in their feeding, and have finally reclaimed and taken them away from their foster-parents. In support of this statement he cites Campbell's "Australian Birds."

We have been favoured with a copy of a circular letter from Hofrath Dr. Franz Steindachner, director of the Royal Museum of Natural History, Vienna, in which attention is directed, in the first place, to the importance of Parà, at the mouth of the Amazons, as a zoological station, and, secondly, to the great value of the biological work which has been carried on there during the last few years by Dr. Emil Goeldi and his able staff of assistants at the "Museum Goeldi." Dr. Goeldi's "Album de Aves Amazonicas," which has been specially noticed in our columns, and Dr. Huber's "Arboretum" are, in Dr. Steindachner's opinion, works of the highest scientific value.

In the *Quarterly Review* for July, Prof. Ray Lankester in an article on sleeping sickness reviews our knowledge of the trypanosomata. He directs attention to the recent researches of Schaudinn, which seem to prove that two blood-parasites, the first a malaria-like one, the Halteridium of birds, the other a spirillum-like form or Spirochæte, are simply phases of trypanosomes. Similarly the parasitic bodies known as the Leishmann-Donovan bodies (Nature, vol. lxix. p. 495), are stated by Rogers to give rise to trypanosome forms. Incidentally Prof. Lankester takes the opportunity to indict the British Government for its supineness with regard to scientific research.

Parts i. and ii. of vol. lxxvii. of the *Zeitschrift für wissenschaftliche Zoologie* contain two long papers devoted to annelid morphology, the one, by Mr. A. Luther, on the "Eumesostomine" rhabdocœlous turbellarians, and the other, by Mr. E. Mattiesen, on the embryology of the fresh-water planarian, or dendrocœlous, turbellarians. Both are of far too technical a nature for detailed notice in our columns, but it may be pointed out that, according to modern principles of nomenclature, the title "Eumestominæ" for the subfamily typified by the genus Mesostoma is a misnomer, the proper term being "Mesostominæ."

The *Entomologist* for July opens with a coloured plate illustrative of three new species of butterflies described in the first article by Mr. W. Dannatt. Various writers record the capture during the present season in different parts of the country of no less than eight examples of the rare striped hawk-moth (*Deilephila livornica*).

The July number of *Nature Notes* contains an account of the annual meeting and conversazione of the Selborne Society held in May last in Burlington Gardens, when a large number of prizes were awarded for work connected with field natural history. The society continues to display its wonted activity in endeavouring to protect such natural and artificial features of the country as appear in danger.

No. 12 of the *Publications de Circonstance* of the International Council for the Exploration of the Sea contains a useful catalogue of the fishes of northern Europe with their names in the different languages of this region. In part xiii*a*. of the same is commenced a detailed account of the present condition of the Swedish and Danish sea-fisheries, illustrated with maps and diagrams.

The *Proceedings* of the Philadelphia Academy for April contain three papers dealing with descriptive zoology, namely, one by Mr. A. Gulick on the fossil land-shells of Bermuda, a second by Mr. J. A. G. Rehn on the bats of the genus Macrotus, and a third by Mr. H. C. Oberholser on the birds of the genus Dendrocincla. More general interest attaches to a communication by Mr. A. E. Brown on post-Glacial Nearctic centres of dispersal for reptiles, of which only the first page is included in the section before us.

The third part of Mr. G. M. Allen's list of the fauna of New England (in course of publication by the Boston Natural History Society) is devoted to the Mammalia, of which eighty-eight species and subspecies are recognised. Old-fashioned naturalists will be somewhat surprised to see well known species figuring under such unfamiliar titles as *Paralces americanus* and *Odocoileus virginianus borealis*.

The *Proceedings* of the Royal Physical Society of Edinburgh for June contain an abstract of the address of the retiring president, Prof. J. C. Ewart, which was devoted to the "making of the elephant," based on recent discoveries in Egypt. In addition to Mr. W. E. Clarke's account of the Færöe mouse, already noticed in our columns, the contents of this number include a paper by Drs. Hepburn and Waterston on the anatomy of the porpoise, and one on colour variation in the viper by Dr. G. Leighton.

In *Science* (July 1) Prof. Long, in an interesting paper, gives an able summary of the relation of modern chemistry to modern medicine. He deals briefly with the action of enzymes, with oxidation in the tissues, with toxins and Ehrlich's side-chain theory, and with the application of physical and mathematical chemistry in the exact study of problems which at one time were assumed to be essentially biological. He finally discusses what should be the proper course of chemistry for the medical student, and concludes that the young man commencing the study of medicine must bring with him a knowledge both of inorganic and organic chemistry sufficiently broad to enable him to grasp the new problems which medicine now presents.

The papers in the July number of the *Journal of Anatomy and Physiology* (xviii., part iv.) are almost all purely anatomical in character. Prof. Arthur Robinson's third Hunterian lecture on the early stages in the development of mammalian ova and an obituary notice of the late Prof. His are the only exceptions.

To commemorate the centenary of the birth of M. J. Schleiden, botanist and naturalist, a short account of his life and works has been prepared by Dr. Mobius, and is published by Engelmann, of Leipzig. Endowed with a controversial temperament and possessed of a ready wit, Schleiden's life was characterised by strenuous activity, but he practically sacrificed his scientific career at an early age in order to plunge into political matters. He is best known for his "Grundzuge der Botanik," which may be described as the first *scientific* text-book of botany. A collection of lectures entitled "Die Pflanze und ihr Leben" was even more successful, as it passed through six German editions, and was translated into English, French, and Dutch.

In addition to the general botanical surveys of a county or a division of a county, there is considerable scope for the investigation of ecological problems on a less extensive scale. In the account of the botanical survey of a pasture which appears in the *Naturalist* (April), Mr. R. C. Gaut describes the characteristic plants which were found, and discusses the causes which enabled the crested dogtail grass to dominate a wet field, while hard by it was replaced by tussock, Yorkshire fog, or foxtail grasses.

In the *West Indian Bulletin* (vol. v. part i.) Mr. Buttenshaw takes up the subject of West Indian starches, their origin and characters. The majority of them are obtained from roots and tubers, and the order Scitamineæ provides a number of plants which store up starch. The writer mentions that the bread-fruit yields a starch suitable for laundry work, and that farinaceous foods can be prepared from the yam-bean, *Pachyrhizus tuberosus*, and "cho-cho" root, *Sechium edule*. In the same number will be found a report on the fruit industry of Jamaica by Mr. W. E. Smith, and a list of the birds of St. Vincent prepared by Mr. A. H. Clarke.

A third report of the special chloroform committee of the British Medical Association has been published (*Brit. Med. Journ.*, July 23, p. 161). Prof. Sherrington and Miss Sowton have continued the perfusion experiments on the isolated mammalian heart (see NATURE, vol. lxviii. p. 351), and find that equal quantities of chloroform dissolved in physiological saline solution, in serum, and in blood respectively exert on the heart very different degrees of depression, chloroform in the salt solution depressing the heart much more powerfully than when administered in blood in the same percentage strength. Mr. Vernon Harcourt gives the results of further tests with his inhaler, and Messrs. Byles and Harcourt and Sir Victor Horsley discuss the estimation of chloroform dissolved in blood.

We have received a copy of the twenty-sixth annual report of the Deutsche Seewarte, for the year 1903. This report marks an important epoch in the history of the Seewarte, owing to the retirement of Geheimrath Dr. G. v. Neumayer, with the title of "Excellenz," after twenty-seven years of eminent service as director of the institution. Under his able guidance the Seewarte has become one of the best organised of the European services, especially in the domain of maritime meteorology and international weather telegraphy. Dr. Neumayer's successor is Rear-Admiral A. Herz, who has the aid of a very efficient staff of assistants. We observe from the report that, like the work of our own Meteorological Office, the useful operations of the Seewarte are constantly increasing. In the department of ocean meteorology, 1169 log-books of various classes were received in the year 1903 against 939 in the previous year, which gave the very substantial increase of 72,563 sets of observations in the year 1903. In the department of weather telegraphy and storm signals great activity has been shown in perfecting the system of 7h. a.m. reports, and in extending it over the whole of Europe. Experiments have also been made with the view of improving the system of signals for giving warning of storms at night, by means of white and red lanterns. Space prevents us from specially mentioning the work of several other departments, but we have frequently had occasion to refer to the valuable publications issued by them from time to time.

In view of the arrangements in progress for continuous temperature observations at the observatory on Monte Rosa, Dr. Emilio Oddone contributes to the *Atti dei Lincei*, xiii. (1), 8, a short note on the values of the mean temperature for the different months of the year, estimated for the Monte Rosa station from other observations. Three different methods have been adopted. The first is based on observations at lower levels combined with corrections based on the temperature gradient; the second is based on temperature observations made in balloon ascents, and the third on 800 temperature observations made in various Alpine ascents, and reduced to the altitude and latitude of the Monte Rosa station. In this way materials have been collected from which it will be possible to infer, in the light of future observations, to what extent the mean temperature of a mountain station can be predicted from observations made elsewhere.

We have received the "Year-book" of the Austrian Central Institute for Meteorology and Terrestrial Magnetism for 1902. A more valuable series of observations and carefully prepared results could not be imagined; the volume contains daily observations or results for 409 stations, including Jerusalem and two other foreign places. The rainfall observations of 2560 stations are separately dealt with by the hydrographic department, and the Philosophical Society of Brünn has also a separate system of some 200 temperature stations, while the observations for Hungary are published by the Hungarian Meteorological Office. The distribution, as regards altitude above sea-level, of the 409 stations contained in the "Year-book" in question is worthy of note:—from 0–500 metres, 252 stations; 500–1000 metres, 111 stations; 1000–1500 metres, 33 stations; 1500–2000 metres, and 2000–2500 metres, 6 stations each; 1 station (Sonnblick Observatory), 3100 metres. We have here all the necessary materials for determining the value of observations on mountain stations for the purpose of weather forecasting, and for discussing other interesting questions as to the effect of altitude on the behaviour of various meteorological elements. A report of an international expert conference as to the usefulness (or otherwise) of the practice of gun firing for the dispersion of hail-clouds ("weather-shooting") is published separately as an appendix to this volume. The director of the Austrian Meteorological Service is Dr. J. M. Pernter.

Although many attempts have been made to prepare mixed anhydrides of organic acids and nitrous or nitric acid, they have always hitherto been fruitless. In the June number of the *Gazzetta*, however, L. Francesconi and U. Cialdea describe the method by which they have succeeded in preparing the mixed anhydrides of nitrous acid and acetic, propionic, and benzoic acids. These

anhydrides, which have the general formula R.CO.O.NO, are obtained by the interaction, at the temperature of a mixture of ice and salt, of nitrosyl chloride with the silver salts of the acids named. They form yellowish oils which may be distilled in a current of carbon dioxide at temperatures not exceeding 70°. On being heated, the vaporised anhydrides explode with violence, so that especial methods had to be devised for their analysis. By water the anhydrides are decomposed into nitrous anhydride and the corresponding organic acid.

IN the same number of the *Gazzetta* L. Francesconi and N. Sciacca establish the remarkable result that, at the temperature of liquid air, nitric oxide cannot be made to combine with a larger proportion of oxygen than that corresponding with the production of nitrous anhydride. Only at temperatures above $-110°$ does nitrous anhydride combine with oxygen to form the peroxide N_2O_4. At $-150°$ nitric oxide readily reduces the peroxide to nitrous anhydride, whilst the latter is stable, under the ordinary atmospheric pressure, at all temperatures below $-21°$. The pure anhydride is, at $-185°$, a dark blue solid which on being melted forms a dark blue liquid.

TO part iii. of vol. i. of *Records* of the Albany Museum Dr. R. Broom contributes four short papers on reptilian and amphibian remains from the Karoo series. Special interest attaches to an anomodont hind foot on account of the mammalian affinities exhibited by the tarsus. A new genus of labyrinthodont (Cyclotosaurus) and one of an endothiodont anomodont (Chelyoposaurus) are described.

THE *Annual Report and Transactions* of the Manchester Microscopical Society for 1903 has just been issued, and is of an encouraging nature. The society has now 181 members as compared with 170 at the end of 1902, and the financial statement is of a satisfactory character. The address which was delivered in December by Prof. S. J. Hickson, F.R.S., as president, on "Variations" is printed in the volume.

IN the *Physikalische Zeitschrift* (No. 14) W. Seitz describes a method of measuring the intensity of the β rays given off by radio-active bodies, in which the converse principle to that adopted by Strutt and by Paschen is made use of. Instead of measuring the positive charge which accumulates on a radio-active body in a vacuum, the magnitude of the negative charge produced by the impact of the rays themselves on an insulated metallic disc suspended in an exhausted glass vessel is determined. The apparatus used lends itself particularly well to the study of the absorption of the rays caused by the interposition of thin sheets of various materials. It is shown that the law found by Lenard to govern the absorption of the kathode rays roughly applies also to the β radiations, namely, that for unit surface the same absorption is caused by equal "masses" of the different materials, these masses being measured by the product of thickness and density. But the law is only approximately true, and, in the case of the elements, there is an increase in the absorption, for equal masses per unit of area, with an increase in the atomic weight.

AMONG papers in the *Verhandlungen der k.k. geologischen Reichsanstalt* for 1904, we note a study by Father R. Handmann of the Congeria-fauna of Leobersdorf, near Vienna (p. 48). The author sustains the view of Dr. Brusina, that this fauna is a northern offshoot from a Croatian centre of development. Dr. O. Ampferer (p. 73) describes in detail the relics of great landslips from the mass of the Tschirgant above the valley of the Inn. These probably occurred in late Glacial times. Travellers by road in this district will know how to this day the hillsides are in a state of unrest and instability. Herr C. von John (p. 104) furnishes a paper of interest to chemists and engineers on the different deductions that may be arrived at as to the heating power of coals, according to the condition and treatment of the sulphur present. This element may exist in organic combination, or in iron pyrites, or in a sulphate, and the mode of calculation adopted may seriously affect the statement of the oxygen present.

IN the *Journal* of the Royal Microscopical Society for June, Dr. A. E. Wright discusses the following four methods of measuring the magnification of a microscope and its elements:—(1) use of a focusing lens placed above the ocular for bringing the emergent rays to a focus in the plane of a suitable measuring scale; (2) separate measurements of the magnifying powers of objective and ocular; (3) measurements depending on Helmholtz's formula; and (4) methods involving the production of a fiduciary phenomenon by means of a diffraction grating.

THE Royal Engineers' *Journal* for June contains the description of a new form of slide rule invented by Major F. J. Anderson. The advantages claimed for it appear, so far as can be judged from the description, to consist in the fact that it can be used with a ducdecimal instead of a decimal scale of notation, and that the numbering of the lines is made absolute, there being separate and parallel scales on the upper limb for numbers from 1 to $\sqrt{10}$, $\sqrt{10}$ to 10, and so forth, and on the lower limb for the square roots of these numbers. Those interested in slide rules will doubtless compare the present instrument with the circular slide rule and the form proposed some time ago, in which the graduations formed a spiral line on the surface of a cylindrical ruler.

IN the *Parents' Review* for July, Prof. J. Arthur Thomson gives a suggestive paper on "Nature and Nurture," in which he discusses some of the problems of inheritance and shows that much may be done to mould the young in spite of the factors of inheritance. Dr. Leslie Mackenzie discusses normal growth in the school ages, dealing with such subjects as work, play, sleep, and diet; Dr. Clouston gives some useful hints on nervous diseases and symptoms of the school age, and Mr. George Smith discusses developmental exercise at school. If parents and others in charge of the young would study such articles as these and put into practice what they teach, the race would grow up healthier and happier.

THE last three numbers of the *Bulletin* of the St. Petersburg Society of Naturalists (2, 3, 4, for 1904) contain a number of interesting communications:—"On the Respiration and the Biology of Enzymes," by I. Warschawsky, S. Kostytschew, N. Maximoff, and M. Lestsch; "On the Tertiary Formations of Crimea and Western Caucasus," by V. Bogatscheff and J. Mikhailovsky, both giving extensive lists of the fossils they have found; "On the Geology of Samara," by W. Lehmann; "On the Peat-bogs of Novgorod," by W. Sukatcheff; "On the Lichens in the Sayans," by A. Elenkin; "On the Volcanic Rocks of the Trialet Mountains in the Caucasus," by B. Kolenko; "On the Fossils Found in the Bolshezemelsk Tundra (North-eastern Russia)," by W. Chitrowo; "On the Survival of the Heart in Mammals," by Th. Thur; "On the Morphology of the Phagocyte Organs of Insects," by O. Dawydoff; "On the Influence of Quinine on the Respiration of Germinating Seeds," by J. Smirnoff; "On the Morphology of the Rust-fungi," by W. Tranzschel; and several smaller notes. All of them are summed up in French or in German.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST:—

Aug. 7. Juno in opposition to the Sun (Juno, mag. 8·7).
10. 7h. Saturn in opposition to the Sun.
10–12. Epoch of the August meteors (Perseids, Radiant $45^\circ + 57^\circ$).
14. 11h. 20m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc = 0·983, of Mars = 0·986.
17. Saturn. Outer major axis of outer ring = 43″·43. Outer minor axis of outer ring = 11″·37.
19. 16h. Mercury at greatest elongation (27° 24′ E.).
23. 11h. 6m. to 12h. 33m. Transit of Jupiter's Sat. III. (Ganymede).
24. 8h. Moon in conjunction with Saturn (Saturn 4° 4′ S.).
30. 8h. Moon in conjunction with Jupiter (Jupiter 2° 7′ N.).
" 14h. 44m. to 16h. 8m. Transit of Jupiter's Sat. III. (Ganymede).
" 14h. 51m. to 16h. 13m. Moon occults ξ' Ceti (Mag. 4·5).

THE CENTENARY OF DOPPLER.—We have received from Dr. Karl Haas a copy of the address that he read on the occasion of the celebration of the centenary of the birth of Christian Doppler. It is strange to reflect that Doppler, in 1842, years before Kirchhoff and Bunsen had demonstrated the possibilities of the spectroscope, first announced the principle bearing his name which has since become so famous and so fruitful of application. He himself was not happy in his original suggestion, for he sought to employ the "principle" as a means of explaining the colour of double stars, and it may be that some of the controversy that at one time raged round this question originated in its faulty application, rather than in the generic principle underlying the suggestion. So far as acoustical waves were concerned the matter could be, and was, settled by experiment, and Dr. Haas not only referred to the various tests that had been made to prove the validity of the "principle," but exhibited some of the apparatus that had been employed, and repeated the experiments. Dr. Haas briefly referred to Doppler's strenuous life and work in other departments of natural science, showing that the enunciation of the principle was not a matter of accident, but that it was led up to by philosophical study, and put before the audience the grounds on which Doppler was entitled to their respect But the valuable work that had been accomplished in the realm of spectroscopy naturally made him linger on this part of the subject, and he gave a useful summary of what has been effected by those who saw how the principle could be applied in special directions; as, for example, Sir William Huggins in the measurement of the motion of stars in the line of sight, Sir Norman Lockyer in the matter of sun-spots and prominences, Dr. Langley and others in the determination of the time of rotation of sun and planets, Prof. Keeler in the spectroscopic observations of the ring of Saturn, and by Dr. Vogel in the department of spectroscopic binaries. M. Belopolsky's scheme for showing experimentally the validity of the principle when applied to light waves was mentioned, while in the department of theoretical physics one was reminded how the application of the same principle was rendering most efficient service. If the centenary served no other purpose, it at least had the effect of tracing the connection between the original thought and its manifold applications.

SATURN'S NINTH SATELLITE (PHŒBE).—The next volume of the "Harvard Annals" is to contain a discussion of Prof. W. H. Pickering's recent observatons of the satellite Phœbe from the photographs obtained at Arequipa.

Meanwhile, in order that other workers may be able to observe this satellite, Prof. E. C. Pickering publishes the following position angles and distances from Saturn on the dates named:—

1904	Position angle	Distance
July 14 ...	77°·4	17′·8
July 24 ...	79°·8	14′·3
August 3	84°·0	10′·5

(*Circular* No. 67, Kiel Centralstelle.)

PRINCIPAL PLANES OF THE STARS.—In the first of a series of papers entitled "Contributions to Stellar Statistics" (published by the Carnegie Institution), Prof. Newcomb discusses "the position of the galactic and other planes toward which the stars tend to crowd."

After demonstrating *in extenso* the formation of the general equation determining the planes, he considers several special cases, and arrives at the following important results, giving the positions of the poles of the respective planes determined:—

	R.A.	Dec.
Galactic plane (omitting branch) ...	192°·8	+27·2
" " (including ") ...	191·1	+26·8
Gould's belt (as determined from 36 stars, of small proper motion, near it) ...	179·6	+26·4
Plane of all stars to magnitude 2·5.	181·2	+17·4
" " " 3·5.	180·0	+21·5
Plane of fifth-type (Wolf-Rayet) stars ...	190·9	+26·7

A determination of the mean latitude of 42 points in the main stream of the galaxy shows that this stream is not, on the whole, a great circle, for the mean latitude obtained is $-1^\circ{\cdot}74$, showing a small but well marked displacement of our system from the central plane towards Coma Berenices, where the north galactic pole is situated.

Gould's values for the poles of his belt were R.A. = 171°·2, dec. = +30°; the value given in the above table reduces his value for the inclination of the belt to the galactic plane by nearly one half.

The above position of the plane containing the Wolf-Rayet stars was determined from the positions of seventy-one such stars (excluding those found in the Magellanic Clouds) communicated by Prof. Pickering, and deviates by only 15′ from the position obtained for the galaxy.

Prof. Newcomb has also investigated the law of "star-richness" of the galactic regions, and among other interesting results records the following numbers as the richness per square degree as determined from the Bonn and Cordoba Durchmusterungs:—

	Bonn DM.	Cordoba DM.
Near galactic pole ...	8·6	29·9
In rifts of the galaxy ...	19·8	45·7
In the galaxy generally ...	24·6	94·1

This result shows that, neglecting the agglomerations, the galactic density is more than double the other in the northern hemisphere, whilst in the southern it is not more than 50 per cent. greater. The general result indicates that, even neglecting the condensation of the Milky Way, the richness increases considerably from the galactic poles towards the equator.

THE PERSIMMON CREEK METEORITE. No. 1380, vol. xxvii., of the *Proceedings* of the U.S. National Museum contains an illustrated description of the physical and chemical characteristics of the meteorite found at Persimmon Creek, North Carolina, in the spring of 1893. The weight of the main mass of this meteorite was 9 lb. 6 oz., but a fragment weighing 1 lb. 13 oz. had been previously detached. The date of the fall is unknown, but the general appearance when found indicated that it had lain in the soil for a considerable period, whilst the inspection of a polished surface afforded evidence of its meteoritic origin, and showed that it was composed of a more or less continuous matrix of iron containing troilite, schreibersite, and carbon. Separate analyses of the various constituents were made, and the results are given in the paper.

ENHANCED LINES OF TITANIUM, IRON, AND NICKEL.—In No. 5, vol. xix., of the *Astrophysical Journal*, Mr. Herbert M. Reese, of Yerkes Observatory, gives a list of wave-lengths in the Ti, Fe, and Ni spark and arc spectra respectively, indicating a fair number of new enhanced lines. The majority of these, however, are only very slightly enhanced, and will require further confirmatory evidence before being finally accepted.

FURTHER EPHEMERIS FOR COMET 1904 *a*.—A supplement to No. 3961 of the *Astronomische Nachrichten* contains a continuation of the ephemeris published by Prof. Nijland in No. 3951 of that journal. This ephemeris gives the positions of the comet for every alternate day from July 18

to October 30, but, as the comet will be only 0·3 of its original magnitude on July 30, and is still decreasing, it is scarcely worth while reproducing it here.

The R.A. is varying but little, and on August 1 will be 12h. 16m. 40s., whilst the declination is slowly decreasing, and on the same date will be $+47° 34'·6$.

A MODIFIED FORM OF THE NEWTONIAN REFLECTOR.—In the *Monthly Notices* for May, 1895, the Rev. Chas. Davies described a modified form of Newtonian reflector in which the rays from celestial objects fell on a large plane mirror fixed at the open end of a horizontal tube, and were thereby reflected on to an ordinary parabolic mirror fixed at the other end, afterwards being brought to a focus through an aperture in the centre of the plane mirror to which was affixed the observing eye-piece. A movement of the plane mirror about the optical axis, and of the horizontal tube in azimuth, allowed any point in the sky to be reached.

By fixing the telescope in a fork at the upper end of a polar axis, M. E. Schaer, of Geneva, now proposes to modify this instrument so that, whilst retaining its original advantages, such as the unchanging position of the eye-piece, it may be used like an ordinary equatorial and cœlostat, and by the simple rotation of the polar axis by clockwork the object may be kept stationary in the centre of the field. In this arrangement the mirrors are so placed that they suffer very little from flexure caused by changes of position. Using a model instrument constructed on these lines M. Schaer found that the practical results were excellent (*Astronomische Nachrichten*, No. 3958).

SEISMOLOGICAL NOTES.

THE sixteenth number of the *Publications* of the Earthquake Investigation Committee in Foreign Languages (Tokyo) consists of 117 quarto pages of print and 9 full-page illustrations. The subject is on Milne horizontal pendulum seismograms obtained at Tokyo, the author of which is A. Imamura, assistant professor of seismology at the Imperial University of Tokyo.

While discussing amplitudes, it is pointed out that these quantities may be increased or decreased according to the relationship existing between the periods of earth movements and the period given to the pendulum, an objection, as has frequently been pointed out, to pendular apparatus in general. Out of a list of 298 records (July 24, 1899, to December 24, 1902), the more important are considered in relation to corresponding records obtained from other types of instruments in Japan, and from similar types of instruments in various parts of the world, the registers from which are issued biannually by the British Association. The more important results relate to the speeds with which different phases of earthquake motion have been propagated over paths of great length. By means of more than forty diagrams, each referring to a particular earthquake, speeds along arcual paths for several of the more important phases of motion are represented by straight lines, that is to say, the speeds are constant. For certain disturbances the evidence leads us to this conclusion, but this is not the case for all. For example, in Fig. 4, a diagram similar to publications by the British Association (Report, 1902, p. 66), we notice in connection with the preliminary tremors that the longer the wave path the greater are the divergencies among the observations which give the time interval to traverse the same. The time taken to travel 25° has apparently varied between 3·5 and 4 minutes, that is to say, the observations agree within 30 seconds. For 80°, however, the divergence is 5 minutes, while on still longer paths the intervals are still greater. When we look at these variations as shown on squared paper, we should certainly hesitate before representing their mean position by a straight line. If, however, it is a straight line, and we know the recording instruments to be similar, then one inference is that minute tremors which may be recorded at a station near to an origin may have failed to reach or to make themselves evident at stations which are very remote.

But why should earthquake vibrations fall in line with the vibrations of elastic bodies? If our world has a fluid or gaseous nucleus, Arrhenius, Fisher, and other physicists and geologists see in the same an explanation for many phenomena. Convection currents might explain slight changes in latitude (Fisher), and they certainly suggest variability of velocity along the same path.

Although we do not agree with all Mr. Imamura's conclusions, seismologists are indebted to him for a piece of valuable research.

In vol. ii., No. 6, of the reports of the Tokio Physico-mathematical Society Mr. K. Honda gives an account of the daily periodic changes in the level in an artesian well the depth of which is 380 m. with a water head within 3·2 m. of the surface of the ground. What he found was that there were two maxima and minima every twenty-four hours, the range of motion varying between 3 cm. and 1 cm. (For somewhat similar experiments made in a shallow well close to the bore-hole here considered, see Reports Brit. Assoc., 1895, p. 104.)

Near to the days of full and new moon the movements are marked and regular; the phases of maxima and minima agree with those of the tides in Tokyo Bay. The well sinks with a high barometer and rises with a low barometer. Rain does not affect the level. By experiment it was found that variation of pressure of 1 mm. of mercury produced a change in the level of the water of 13·5 mm. An equal natural pressure acting on the water head causing it to sink, and on the surrounding ground causing it to rise, only results in a level change of 4·35 mm. From this it is concluded that the earth's crust only transmits 68 per cent. of pressure on its surface to a depth of 380 m. Another conclusion is that the daily fluctuation of 1 to 3 cm. is more likely to be a tidal than a barometrical effect. The distance to the sea is 3 km. In a deep well in Yokohama 0·6 km. from the sea, the tidal effect results in a change of level of 16 cm. This extremely interesting paper concludes with references to the frequency of earthquakes in relationship to fluctuation in barometric and tidal loads. In No. 9 of the same reports Mr. Honda gives a continuation of similar researches carried on at three other deep wells, at the end of which he shows that earthquakes with a submarine origin are most frequent when tidal pressure is at maximum, a minimum, and when the rate of pressure is changing most rapidly. No. 8 of the *Journal* is from the pen of Dr. F. Omori, who shows, chiefly from the consideration of after shocks, that earthquake frequency is affected by changes in atmospheric pressure.

Consul G. Pára, of Uskub, gives (*Kaiserliche Akad. d. Wissenschaften in Wien*, April 21, No. 10) a few statistics relating to the destruction caused by the earthquake which on April 4 disturbed the Balkans. This is followed by further details of a more geological character by Prof. R. Hoernes. The phenomena described are of an ordinary character.

Under the title of "L'Eruzione dell' Etna in 1892," (vol. i.), in a large quarto volume, the director of the observatory in Catania, Prof. A. Ricco, and S. Arcidiacono give a detailed account of the phenomena which accompanied the eruption of Etna in 1892. As an assistance to the better understanding of the historical sequence in events, this is prefaced by accounts of the eruptions of 1883 and 1896, all of which took place on the line of a radial fracture at points from 1000 to 1500 m. lower than the main central crater. It is essentially a volume of observations of value to the vulcanologist, to be followed at a later date by deductions.

In the *Bollettino dell' Accad. Gioenia, Catania*, fas. lxxix., December, 1903, S. Arcidiacono gives a short account of earthquakes which recently disturbed Etna, and which were of local origin. From a tabular statement of these it appears that from 1898 seismic activity was fairly uniform and not pronounced, but after the eruption of 1902 it became three-fold.

The first paper in the *Bollettino della Società Sismologica Italiana* (vol. ix., No. 9, 1903–4), by M. Tito Alippi, relates to the possible relationship of *bonniti* and *bombiti* (mist poeffers, barisal guns, &c.) to seismic movements. From a list of seismic disturbances recorded in a district where *bonniti* were frequent, it does not appear that the two phenomena are connected. The multiplication of the seismograph was, however, only 12. Had it possessed ten times this sensibility it might have responded to minute

tremors propagated in the soil, and quickly afterwards to movements produced by air waves acting on the building, and then to the instrument. A second paper, by the late Dr. M. Contarini, is on the choice of earthquake recorders. Although the paper is short it contains good advice. We are told first to select our instrument according to the object we may have in view. If we wish to record earthquakes of local origin, a type of instrument may be used different to that which will record disturbances with their origins as distant as the antipodes. Again, an instrument which may record the times of arrival of certain phases of motion may not be able to analyse the same; in fact, for earthquakes of distant origin it is doubtful whether an instrument yet exists that gives a true record of the movements of the soil.

At the end of the number the Italian catalogue of shocks of local and of distant origin is brought up to the end of September, 1902.

In an interesting article of twenty-eight pages, M. Paul Choffat gives in *Communicações du Servia Geologique du Portugal* (Tome v., pp. 279–306) an account of "Les tremblements de terre de 1903 en Portugal," to which he adds notes relating to earthquakes which took place in previous years. From the conclusions we learn that there are two chief centres from which disturbances felt in Portugal originate, one of which is suboceanic off the mouth of the Tagus, from which the great Lisbon earthquake of 1755 radiated, and the other is in Andalusia, the shocks from which are comparatively feeble. There are also several local centres.

AGRICULTURAL NOTES.

THE officials in charge of the County Technical Laboratories at Chelmsford are engaged in an investigation that will commend itself to Londoners; they are trying to gain some information as to the natural causes bringing about variation in the composition of milk. Two reports dealing respectively with the winter and summer months of the past year have been issued. From the latter we learn that in Essex milk is poorest in the months of July and August. This is the common experience of dairy farmers. It is when the pastures begin to dry up that the quality of milk suffers most. In the Essex experiments four cows were kept under observation from May until September, and two others for a shorter period. The yield of milk fell off at the rapid rate of 10 per cent. per month; with this decline there was an increase in the proportion of fat, but no regular increase in the case of solids not fat. In the month of July the percentage of non-fatty solids decreased in the milk of every animal. The milk of four of the cows, and the mixed milk of the six animals, never fell below the standard in solids not fat, but two of the cows often failed in this respect. The mixed milk and the milk of one of the cows never contained less than the standard quantity of fat, but the milk of two of the cows frequently, and the milk of two others occasionally, contained less than the required 3 per cent. of fat.

In connection with the investigations on nutrition, which form an important part of the work of the Storrs Agricultural Experiment Station, Conn., analyses have recently been made of the flesh of many kinds of fowl. The analyses were published in the annual report of the station for 1902–3, and some account of them is also given in a recently issued bulletin on "Poultry as Food." The bulletin contains a table showing the composition of the digestible nutrients in the flesh of poultry; comparisons are made between young and mature birds, and also between poultry and other common articles of diet. The meat of light-fleshed birds is shown to be usually richer in albuminoids and poorer in fat than the meat of dark-fleshed; and among light-fleshed fowls chickens supply a more nitrogenous food than mature birds; on the other hand, in dark-fleshed fowls the flesh of the young appears to contain more fat and less albuminoids than the flesh of older birds. The following figures show that the breast, or breast and wings of poultry, usually contain more albuminoids and less fat than the legs or dark meat. The analyses were of raw meat. Cooking may materially alter the proportion of fat.

	Digestible nutrients	
	Albuminoids	Fat
	Per cent.	Per cent.
Chicken, light meat	21·2	7·0
,, dark ,, ...	20·2	7·8
Turkey, light meat	25·0	10·7
,, dark ,, ...	19·4	23·8
Duck, breast	21·6	2·2
,, other parts	16·9	24·8

An important paper containing a summary of Koch's investigation of Rhodesian red-water, or, as he prefers to call it, African coast fever, appears in the May number of the *Agricultural Journal* of the Cape of Good Hope. This disease of cattle, introduced from the coast, has recently worked havoc in Rhodesia, the mortality among the herds of certain districts having risen to 90 per cent. Like Texas fever, with which it was at first confounded, coast fever is due to the presence of a tick-conveyed parasite in the blood. An animal which has recovered becomes immune, and, according to Koch, a proportion of the progeny contract the disease in a mild form as calves and also become immune, so that an immune race will gradually form in the same way as a partially immune population is to be found in many of the most deadly malaria districts. In the absence of ticks, coast fever cannot spread. Unlike Texas fever, injection of the blood of a diseased animal will not produce the disease. But Koch has shown that repeated injections result in a mild fever which is sufficient to confer partial, and in his opinion a high degree of immunity. On this fact is based the treatment which he recommends for the disease, the injection of 5 c.c. of defibrinated blood from a sick or "salted" animal about seven times at intervals of a fortnight. This treatment he believes will in four or five months confer immunity. Inoculation is absolutely safe, for of 3115 "clean" animals treated not one died, and the treatment is so rapid that an operator can deal with 300 to 500 per day. Of the efficacy of the treatment it is clear that Koch has a high opinion, though he is careful to point out that his experimental evidence is not yet complete. Of 1688 animals that had been exposed to infection and were inoculated, 174 died. As in many of these cases inoculation must have been too late to benefit, Koch argues that the number dying because inoculation failed to protect must have been very small. In view of the very high death rate in unprotected herds it would appear that the proposed treatment is of high promise.

But Koch's views on the value of inoculation do not seem to be shared by all the experts who are now engaged in the study of African coast fever, and the Government entomologist, Mr. Lounsbury, who has made a careful study of the tick conveying the disease, appears to favour the use of arsenical dips, which, by destroying the tick, would put an end to the ravages of coast fever. Lounsbury speaks of these dips as an "effectual remedy," while Koch characterises their use as a "temporary" measure. Mr. Lounsbury publishes an interesting account of the experiments by which he proved that the infection was carried by the common brown cattle tick of South Africa (*Rhipicephalus appendiculatus*). He failed in ten experiments to convey it through the blue tick, which Koch says is partly responsible for transmission. In a preliminary experiment Lounsbury proved that brown ticks taken from sick cattle in Rhodesia produced coast fever in Cape Colony. Brown ticks were then collected in a region in the colony in which coast fever was unknown. From these ticks progeny were raised, the majority of which were fed throughout life on healthy cattle without causing any disturbance in health; others were taken to Rhodesia and placed on a sick cow; they were then taken back to Cape Colony and put, at intervals of a few days, on three cattle. "The results were most decisive. The three animals sickened each in turn about a fortnight after the infestation," and all died. This experiment was repeated, and it was found that a single tick could produce the disease. Lounsbury notes that one of the cattle which died in his experiments had previously been inoculated ten times from an animal pronounced by Koch to be suitable as a "bleeder."

While in South Africa Koch has studied horse-sickness, and in a recent report on his work he speaks of "encouraging results which . . . impress me with the conviction that a practical method of protective inoculation against Horse-sickness is within our reach." A serum has been prepared which has slight curative but high protective properties. Unfortunately, the immunity conferred by the serum lasts only for some fifteen days, so that a horse cannot be "salted" by inoculation, and to be safe from an attack the animal must have already had horse-sickness in some form. The "practical method" which Koch proposes consists in producing horse-sickness by an injection of virus, and then arresting its progress by injections of the protective serum before it becomes dangerous. The method has been practised successfully on more than a dozen animals. As the result of his experiments Koch recommends the following treatment:—Seven injections of virus at intervals of twelve days, the doses increasing from 0.01 c.c. to 5 c.c. Four days after each of the first three injections of virus, doses of 100 c.c., 50 c.c., and 50 c.c. of protective serum to be given. The injections of both virus and serum are made subcutaneously in the neck.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Frank Smart studentship in botany has been awarded to Mr. A. M. Smith, of Emmanuel College.

Mr. E. R. Burdon, of Sidney Sussex College, has been appointed assistant curator of the botanical museum.

Science announces the resignation of Prof. G. Trumbull Ladd as head of the department of mental philosophy and metaphysics of Yale University.

LORD STRATHCONA has given 4000*l.* to the scientific department of the Manitoba University. A block of land sufficient to yield a large annual income is also to be placed at the university's disposal.

THE chair of chemistry in University College, Sheffield, has been accepted by Dr. W. P. Wynne, F.R.S., at present professor of chemistry in the School of Pharmacy of the Pharmaceutical Society of Great Britain.

DR. C. SCHUCHERT, of the U.S. National Museum, has been appointed professor of historical geology in the Sheffield Scientific School of Yale University, and curator of the geological collections in succession to the late Prof. Beecher.

THE "Year-book" for the session 1904–5 of the Armour Institute of Technology, Chicago, a copy of which has reached us, contains full particulars of the course in fire protection engineering instituted last year. The course is arranged to furnish instruction in modern methods of fire prevention and extinction. Since fire insurance interests are closely connected with the work of the course, a portion of the time of senior students is devoted to the study of modern practice of fire underwriting. Prof. Taylor, who is in charge of this department of the institute, has rightly given great prominence in his syllabus to the scientific principles upon which successful work in fire extinction depends.

THE consultative committee to the Board of Education has submitted a number of suggestions to the board for a system of school certificates. The committee is of opinion that, with the object of diminishing the multiplicity of examinations affecting secondary schools, and of providing a test of adequate general education which may be widely accepted, a general system of school certificates is desirable. The committee does not think it is desirable that examinations for such certificates should be conducted by means of papers set for the whole country from a single central organisation. It suggests that such examinations should be controlled by a recognised examining body, which should be either a university or a combination of universities, or an examination board representative of a university or universities, and of the local authorities which are prepared to cooperate with them. It proposes that recognition of these examining bodies should mean recognition by the Board of Education, acting on the advice of the consultative committee. The establishment is suggested of a central board for England consisting of representatives from the Board of Education and from the different examining bodies, the duty of which should be to coordinate and control the standards of these examinations, to secure the interchangeability of certificates, and to consider and, as far as possible, to adjust the relations of the examining bodies and their spheres of external action. There can be little doubt that some such plan as the consultative committee proposes would enable schoolmasters to utilise in the better education of their boys much of the time now absorbed by the preparation for numerous special examinations.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 11.—M. Mascart in the chair.—Thermochemical investigation of the solution and polymerisation of cyanogen: M. **Berthelot.** Potassium cyanide has considerable thermal effect on a solution of cyanogen whether in water or alcohol.—Note on the heat of transformation of black crystalline sulphide of antimony into the orange coloured precipitate: M. **Berthelot.**—Condensation of glycol bromoacetate with acetoacetic and acetone dicarboxylic esters: A. **Haller** and F. **March.**—Origin in food of the arsenic normally found in man: Armand **Gautier** and P. **Clausmann.** Practically all food materials, particularly fish, contain traces of arsenic, the total arsenic received by an average man in a year being 7·66 mg.—The relation between external work and total expenditure of energy in a muscle in dynamic contraction, when the muscle is doing negative work, against the fall of a load, by gradually elongating as the load falls: A. **Chauveau.** It is concluded that the expenditure of energy is greater in negative work than in fixed contraction, but less than in positive work under the same conditions of load, stimulus, &c., and that in negative work the expenditure of energy increases more rapidly, when the work is increased by increase of load, than by increase of movement.—Note on a new method of observing *n*-rays: R. **Blondlot.**—Analysis of the ashes contained in the urns of Materpa (Thebes, eighteenth dynasty): MM. **Lortet** and **Hugoumenq.**—Regulation of watches at sea by wireless telegraphy: J. A. **Normand.**—The academy appointed MM. Mascart, Troost, Moissan, Guyon, and Lacroix to assist at the inauguration of the Pasteur monument in Paris.—Two problems on isothermic surfaces: L. **Raffy.**—Explosion waves: E. **Jonguet.**—Kathode rays and magnetofriction; reply to Villard: H. **Pellat.**—Note on the refractive indices of solutions: Edmond **Van Aubel.**—The relation between the pressure of a gas in a vacuous tube and the length of the spark produced: Gaston **Séguy.** As the pressure decreases in geometric progression the length of the spark increases in arithmetic progression.—The densities of sulphurous anhydride and of oxygen: Adrien **Jaquerod** and Alexandre **Pintza.** Morley's method of weighing the gas by the loss in weight of the generating apparatus was used with concordant results in the case of sulphurous anhydride.—The heat of combustion of organic sulphur compounds, and a note on that of compounds containing halogens: P. **Lemoult.** Results of experiments are compared with those obtained by calculation according to the position of the sulphur.—Reactions of the esters of 2:3-butanonic acid. (1) Action of phenyl hydrazine: L. **Bouveault** and A. **Wahl.** The phenyl hydrazone obtained in the cold is proved to be that in the 2-position by the formation of the paranitrophenyl hydrazone of methyl phenyl acetopyrazolone previously obtained by Bülow.—Researches in the pyrane series: E. **Blaise** and H. **Gault.**—On some phenolic ethers of the pseudo allyl chain $R—C(CH_3)=CH_2$: MM. **Behal** and **Tiffeneau.** These bodies are obtained by the magnesium methiodide reaction on the corresponding esters, using one or two molecules in excess of the magnesium methiodide, and are intermediate between the corresponding allyl and isoallyl compounds in boiling point, density, and refractive index.—Action of traces of some salts, and of caustic alkalis on diphenyl carbonic ester: R. **Fosse.**—Mechanism of the action of the cytoplasm in seeds during germination, and the synthetic realisation of this mechansm *in vitro*: Maurice **Nicloux.** The development of acid in oily seeds, when

germinating, is proved to be due to the hydrolytic action of the cytoplasm on the oil. The name *lipaséidine* is proposed for the active substance in the cytoplasm. The action requires some acid to start it, but CO_2 is proved by experiment *in vitro* to be sufficient, and CO_2 is produced in germination.—A new trypanosome in birds: M. **Thiroux.**—Some phenomena during ovogenesis among the cirripedes, particularly in *Scalpellum velutinum*: A. **Gruvel.**—On the structure of the heart in gasteropods and lamellibranchs: F. **Marceau.**—On the development of black rot (*Guignardia Bidwellii*): P. **Viala** and P. **Pacottet.** For rapid development black rot requires a warm temperature and a moist atmosphere, but at low temperatures growth proceeds slowly. It is, moreover, highly resistant towards acids and toxic substances generally.—Garéwaite, a new fibrous basic rock of the North Urals: L. **Duparc** and F. **Pearce.**—Stationary waves observed in the neighbourhood of the human body: Augustin **Charpentier.**—Localisation of iodine in the African turtle: MM. **Doyon** and **Chenu.** Action of salts of the alkaline earths on living substance: N. C. **Paulesco.**—Influence of sterilisation on food-stuffs: A. **Charrin.**—On the contractility of protoplasm, i., action of chlorhydrate of amyleine on ciliary movement: L. **Launoy.**—On the supposed chlorophyll of silk: Jules **Villard.**

July 18.—M. Mascart in the chair.—Experiments on the slow oxidation of cyanogen and cyanides by free oxygen: M. **Berthelot.** The absorption of oxygen from air by the following solutions is examined:—potassium cyanide, hydrocyanic acid, and cyanogen in water and in alcohol, alcohol alone, and alcoholic potash, also by these solutions in the presence of mercury. Absorption of oxygen is observed in every case, but becomes more rapid when the tube is heated or exposed to light. When mercury is present, the absorption of oxygen causes solution of some mercury, particularly with the cyanides.—The natural immunity of cynocephales towards trypanosomiases, and the activity of their serum towards trypanosomes: A. **Laveran.**—Hypsometric tables of Cretaceous strata in the north of France: J. **Gosselet.**—Pamphlets presented to the academy:—Considerations on the principles of arithmetic: L. **Gros.**—Researches on the quantity of citric acid in wines: Lucien **Robin.**—A work on tables of corrections of the times of the moon's rising and setting: S. **Abdullah.** A supplement to the general problems of flight: M. **Averly.**—The secretary read several telegrams concerning the earthquakes of July 12 and 13.—Steered balloons. Longitudinal stability: Ch. **Renard.**—On the anomalous propagation of light in the neighbourhood of a focal line, and on the interference of vibrations the amplitudes of which are different functions of the distance: G. **Sagnac.**—On the disappearance of some of the silicon lines in the spectra of certain stars: A. **de Gramont.**—Variation of the index of refraction of an electrolyte under the action of the current: H. **Bordier.** Chlorides of copper and of zinc were used. It was found that, when the current is constant, the reduction of index of refraction decreases with increase in the concentration of the electrolyte, whilst, when the concentration is constant, the decrease of refractive index plotted in a curve against the strength of the current forms a straight line.—The influence of the density of the current in electrolysis with alternating current: André **Brochet** and Joseph **Petit.** Nickel electrodes in a solution of potassium cyanide were used, and the relation between the amount of nickel dissolved and the density of the current investigated for different frequencies, when the time and total current were constant.—On the fundamental law of the phenomena of osmosis: E. **Ariès.**—On the constitution of dissolved salts: Albert **Colson.** The formula

$$HSO_4Zn—O—Zn—SO_4H$$

is assigned to zinc sulphate from considerations of the basic sulphates obtained by alkalis, and of the freezing point of solutions of zinc sulphate.—On some crystalline iodates of copper: A. **Granger** and A. **de Schulten.**—Dextrolactic acid and lævolactic acid are not alike in their reactions: E. **Jungfleisch.** *l*-Lactic is much more easily racemised than *d*-lactic, so much so that in separating *d*- and *l*- from *in*-lactic by the quinine salts, *d*-lactic is easily obtained, but the supposed *l*-lactic is mainly $d+l$.—Orthophosphoric anilide and its homologues; the non-existence of the compound $C_6H_5NH—P\equiv(NC_6H_5)_2$: P. **Lemoult.** Condensation of acetylene ketones with alcohols and phenols: Ch. **Moureu** and M. **Brachin.** Action of oxalacetic ester on benzaldehyde in the presence of primary amines: L. J. **Simon** and A. **Conduché.** The heat of neutralisation and acidity of monomethylarsenious acid: A. **Astruc** and E. **Baud.**—On a frequent source of error in the analysis of coal: Just **Alix** and Isidore **Bay.**—On some points in the anatomy of the cirripedes: A. **Gruvel.**—Antimeridian plants: Édouard **de Janczewski.**—Carpellised stamens of the wallflower: C. **Gerber.**—Bravais's law considered as a law of observation: G. **Friedel.**—A new theory of ouralitisation: L. **Duparc** and Th. **Hornung.**—On the terraces of the Carpathian rivers in Roumania: E. **de Martonne.**—Researches on the genital poisons of different animals: Gustave **Loisel.** The extract of an ovary is always more poisonous than that of a testis, and varies in different animals, that of the frog being most poisonous towards a rabbit. The toxic effect is nervous, producing tetanus and dyspnœa.—The influence of lactation on the resistance of the organism to morbid agencies: MM. **Charrin** and **Vitry.** A female in lactation is less resistant than the normal to alkaloids and bacteria.—The mechanical cleansing of the blood: Ch. **Répin.** To remove poisonous substances from the blood a method is used by which the plasma is removed, being replaced by artificial serum, but the corpuscles, being separated centrifugally, are immediately returned to the blood stream.—Researches on arsenic in some food-stuffs: V. **Bordas.**—A new contribution to the bacterial purification of spring and river waters by means of fine sand, which is not submerged: P. **Miquel** and H. **Mouchet.**—On the duration of the experiments in the treatment of arterial hypertension by d'Arsonvalisation: A. **Moutier.**—On a new type of piezometer: M. **Buchanan.**—The Hirondelle deep in the archipelago of the Azores: M. **Thoulet.**

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THURSDAY, AUGUST 4, 1904.

"MUTATION" v. SELECTION.

Evolution and Adaptation. By Thomas Hunt Morgan, Ph.D. Pp. xiii+470. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 12*s.* 6*d.* net.

THE author of the present work is one of those biological theorists who, while accepting the doctrine of evolution, and apparently admitting that natural phenomena must be capable of rational explanation, yet think it necessary to adopt a severely critical attitude towards the only principle which seems able to account for the facts of organic development, the principle, namely, of selection, as first propounded and illustrated by Darwin and Wallace.

Among the difficulties which those who impugn the doctrine of selection have to face, the existence of adaptation in every department of organic nature is one of the most formidable. After every allowance has been made for hasty allegations which further knowledge has tended to disprove, there remains an immense body of facts relating to the adjustment of organisms to their surroundings that demands to be accounted for in accordance with the known laws of nature. What rational means of explanation are still open to those who would dispense with the Darwinian key to the puzzle of adaptation? This is, in brief, the question which Dr. Morgan asks and attempts to answer in the volume before us. It is true that his acceptance of the facts of special adjustment is somewhat grudging; even in the case of Kallima, which, as Weismann says, is "decisive for adaptation," he appears to question the utility of the very perfect concealment afforded by the underside. But whatever scepticism he may be justified in showing with regard to particular instances, neither he nor anyone else can deny with reason the general principle of adaptation. It must be set down to the author's credit that he does not seek refuge in the views of the Lamarckian school, whether new or old:—

"Despite the large number of cases that they (the Lamarckians) have collected, which appear to them to be most easily explained on the assumption of the inheritance of acquired characters, the proof that such inheritance is possible," he justly says, "is not forthcoming."

Where, then, are we to find a solution of the mystery? The answer, according to Dr. Morgan, lies in the "mutation theory" of De Vries. But here comes in a curious inconsistency of which the author himself seems to be partly, but only partly, aware. If he urges one point with greater insistence than another, it is that De Vries's theory "stands in sharp contrast to the selection theory." Yet the whole drift of his argument goes to show, though he seldom acknowledges it in so many words, that even if De Vries's account of "variations" and "mutations," and of the relation between them be accepted, selection must still be called in to explain the aspect of the world around us.

Let us for the moment lay aside the subject of the nature of variation, admitting that it is capable of a more minute analysis than Darwin gave it, and that much remains to be learned concerning different kinds of variation and their power of transmission by heredity. We are still face to face with the question, "How is it that the favourable variations form the majority of those that we see? What has become of the others?" The answer shall be given in Dr. Morgan's own words:—

"Over and beyond," he says, "the primary question of the *origin* of the adaptive, or non-adaptive, structure is the fact that we find that the great majority of animals and plants show distinct evidence of being suited or adapted to live in a special environment, *i.e.* their structure and their responses are such that they can live and leave descendants behind them. I can see but two ways in which to account for this condition, either (1) teleologically, by assuming that only adaptive variations arise, or (2) by the survival of only those mutations that are sufficiently adapted to get a foothold. Against the former view is to be urged that the evidence shows quite clearly that variations (mutations) arise that are not adaptive. On the latter view the dual nature of the problem that we have to deal with becomes evident, for we assume that, while the origin of the adaptive structures must be due to purely physical principles in the widest sense, yet whether an organism that arises in this way shall persist depends on whether it can find a suitable environment."

What is this but selection? The fineness of the distinction here drawn appears to have struck the author himself, for he immediately adds:—

"This latter is in one sense selection, although the word has come to have a different significance, and, therefore, I prefer to use the term *survival of species*."

We need not dispute over the term, provided that the principle, which is essentially Darwin's, be admitted.

The more we examine Dr. Morgan's argument as against Darwin, the greater difficulty do we experience in defining the precise point at issue between them. It is not the origin of variation; for if Darwin did not attempt to account for this, neither does De Vries. Nor is it the existence of the discontinuous variations called "mutations" by De Vries, for some of these were well known to Darwin. Nor, again, is it the principle of selection; for this, as we have seen, is virtually admitted on all hands. We might have been inclined to say that it was the question of the origin of species by large as against small variations, but for the fact that the author expressly states that "as De Vries has pointed out, each mutation may be different from the parent form in only a slight degree for each point." We are reluctantly impelled to the conclusion that the controversy is rather of a personal than of a material nature, and that at the root of it lies a kind of jealousy—no doubt unconscious—of Darwin's position and influence. It would

doubtless be unfair to say of the author that, so far as his treatment of Darwin is concerned—

> "Willing to wound, and yet afraid to strike,"

he would

> "Just hint a fault, and hesitate dislike;
> Damn with faint praise, assent with civil leer,
> And without sneering, teach the rest to sneer"—

but we cannot acquit him of a somewhat captious method of dealing with Darwin's clear and well considered utterances. We have seen of late a great deal of groundless objection to the Darwinian position, and many quite uncalled-for attempts to minimise the value of the Darwinian contribution to evolutionary theory. We may freely concede that the opinion expressed in the "Origin of Species" in favour of the transmission of acquired characters has not stood the test of investigation; but this is a negligible matter in comparison with the enormous impulse to evolutionary theory given by the doctrine of selection, which doctrine it was the peculiar merit of Darwin and Wallace to have presented in such a form as to command the attention of all scientific workers, and the assent of most. It cannot be said that the various attempts to dispense with selection have met with success, and in spite of the "carpers carping with their carps," we think that the Darwinian treatment of variation and selection still affords the only basis for a reasonable account not only of adaptation, but also of the origin of species.

F. A. D.

THE FAUNA AND FLORA OF ALASKA.

Harriman Alaska Expedition. Edited by Dr. C. H. Merriam. Vol. v. Cryptogamic Botany (pp. ix+424). Vols. viii. (pp. ix+238) and ix. (pp. 284). Insects. Vol. x. Crustaceans (pp. 337); illustrated. (New York: Doubleday, Page and Co., 1904.)

FROM time to time brief notices have appeared in our columns of various issues of "Papers from the Harriman Alaska Expedition," published in the *Proceedings* of the Washington Academy of Sciences. The whole of these papers, together with others hitherto unpublished, are now in course of re-issue in the form of a series of handsome and well illustrated volumes, with the title cited above, and under the editorship of Dr. C. Hart Merriam, the well known chief of the Biological Survey of North America. As the various papers are reprinted from the original electrotypes, and the original pagination is given in brackets, there is no likelihood of any confusion arising by quoting from the re-issue. Of these volumes, four are now before us.

Before going further, it may be well to state that the work does not attempt to give a complete account of the fauna and flora of the Alaskan peninsula. In the insect volumes, for example, many of the papers deal only with the material brought back by the expedition, although in a few instances the existing state of our knowledge of each group is given so far as Alaska is concerned. Even where no attempt is made to formulate complete lists, in many cases the material obtained was, however, so extensive as to include the greater part of the representatives of the group described. In every instance the description and identification of the specimens collected have been assigned to specialists.

The volume on cryptogamic botany contains not only the new information acquired as the result of the expedition, but an account of the previous state of knowledge of the subject. Special interest attaches to the general account of Alaskan vegetation given in the introduction. The southern districts of Alaska, it appears, are characterised by the grandeur of their forests and the brilliancy of the flowers beyond the forest tract, the usual alpine conditions prevailing above the timber belt. Closer examination even of the wooded area reveals, however, a wealth of flowerless vegetation which gives to the flora a character it would otherwise lack; while the flowers of the mountain tops and prairies are set in beds of moss and fern. In the forest, owing to the abundant rainfall, every mouldering log, as well as the standing stems, are clothed with moss, which carpets the ground, and hangs in festoons from the branches. Among the mosses and liverworts grow many of the more delicate flowering plants, while the many fleshy funguses make this carpet their special home. The open glades are occupied by peat-mosses (Sphagnum) in considerable variety, which afford a basis for cranberries, sundews, and butterworts. North of the forest zone appears a wet, boggy tract, passing into the frozen Arctic tundra, the mossy carpet of which is, however, spangled in summer with a perfect blaze of flowers. In these open areas ferns grow in great luxuriance, and on Kadiak Island the traveller may wade through beds of bady-fern nearly waist-deep.

No less than eight specialists have given their services to the determination and description of the cryptogams collected during the expedition.

Passing to the volumes on insects, we have to note, in the first place, that this department in the expedition was confided to Prof. Kincaid, of Washington University, who collected some 8000 specimens, representing about 1000 species, and, secondly, that under the general title of insects are included both myriapods and arachnids. In the first of the two volumes, special value attaches to the paper on myriapods by Mr. O. F. Cook, since it treats of all the known members of that little-worked group hitherto obtained from north-western North America. Previous to the Harriman Expedition, our knowledge of the Alaskan insect fauna was mainly restricted to the Coleoptera and Lepidoptera, and consequently special efforts were made to collect the other groups. The result has shown that Alaska possesses a rich entomological fauna which awaits other collectors to reveal fully. Out of the 1000 species collected, 344 have been regarded as new to science. Special attention was devoted to the study of the adaptation of Alaskan insects to their surroundings, more particularly in the Sitka district, where the annual rainfall attains the enormous total (for a non-tropical or subtropical zone) of 105 inches. As might have been expected, the Diptera were found to form the predominating element in the insect fauna, but of this group only a small percentage has hitherto been, in all probability,

collected. In addition to those on myriapods and arachnids, the first of the insect volumes includes papers on Alaskan Coleoptera, Lepidoptera, Neuroptera, Orthoptera, Homoptera, and various minor groups. Special interest attaches to the chapter by Prof. Kincaid on the metamorphoses of Alaskan Coleoptera, in the course of which the author points out that the prevalent idea as to the extreme difficulty of rearing adult beetles from their larval condition is to a great extent founded on error.

The second of the two volumes on insects (ix.) is devoted to the Diptera and Hymenoptera, the article on the former being written by Mr. W. Coquillett, and the one on the latter group by Mr. W. H. Ashmead. In addition to these are three minor papers on certain sections of the aforesaid groups. A sample of the excellent results of Prof. Kincaid's energetic collecting is afforded by the case of the Hymenoptera, in which group less than thirty species were known from Alaska previous to the expedition, while the number now recorded is no less than 335, 201 of these being regarded as new to science. Of Diptera, 2423 specimens, representing 276 species, were collected, out of which one genus and 63 species are described as new.

As regards the volume on crustaceans, the great bulk of this is occupied by Miss Rathbun's elaborate and exhaustive memoir on the decapod section, Miss Richardson contributing a short account of the isopods, while Messrs. Holmes and Cole are severally responsible for the amphipods and pycnogonids, or sea-spiders. Miss Rathbun has treated her portion of this extensive subject from a very broad standpoint, discussing the crabs and shrimps not only of the Alaskan seas, but of the western coast of America generally, from the Arctic Circle to southern California. The decapod fauna of the North Pacific has proved very rich in individuals, if not in species. Among the more abundant types are the hermit-crabs, of which many species have local centres of distribution, where they attain their maximum development, both as regards size and numbers. In certain localities this crowding of crustacean life has been specially favourable to the development of parasitism. The decapods form the staple food of many kinds of fishes, and certain species are commonly used by fishermen as bait, or caught for the table. In many cases the northern limits of the species are determined by the winter line of floating ice in Bering Sea.

As regards the other groups, it must suffice to say that while Mr. Holmes restricts himself to the amphipods collected during the expedition, the isopods and pycnogonids of the whole western coast, from Alaska to California, are discussed. It is perhaps this variation in the mode in which the different groups are treated that constitutes the main ground for criticism in regard to the general plan of this magnificent and valuable work. Both editor and contributors are to be congratulated upon the results of their labours, so far as these are at present before the public, while the thanks of the scientific world are especially due to Mr. Harriman, as the generous provider of the means whereby this important addition to knowledge has been rendered possible. R. L.

THE THEORY OF DETERMINANTS.

The Theory of Determinants. By R. F. Scott, M.A. Second edition. Revised by G. B. Mathews, M.A., F.R.S. Pp. xi+288. (Cambridge: University Press, 1904.) Price 9s. net.

THIS well known treatise has been revised and enlarged in several respects. For instance (chapter xi.), the theory of linear equations is more complete than in the first edition, and Bezout's method of elimination is explained, as well as Sylvester's.

An introductory chapter has been inserted, containing an elementary account of three-rowed determinants; this should prove a considerable help to beginners. As a whole, the new edition is probably easier reading than the first; but even now the style seems rather too condensed for the average reader, and illustrations of general theorems by special cases are somewhat scarce.

A chapter (x.) on infinite determinants has been added; this appears to be based on the work of von Koch and Cazzaniga, but as some investigations have been abbreviated, occasional difficulties may be encountered at a first reading. Thus von Koch's proof that a normal determinant converges (art. 5) would be clearer if reproduced in full, and the convergence-test employed here[1] might be explained at greater length. The investigations of arts. 6 and 10 assume that certain infinite sequences (α_{ik} and C_{ik}) have upper limits; von Koch establishes this property by comparison with infinite products.

Semi-normal determinants are defined, in art. 11, after Cazzaniga; von Koch's definition would give a more elegant form to the theory without loss of generality. The two rules for multiplying semi-normals are stated in art. 12; but C is not proved to be equal to AB, and the statement (p. 128) "the series c_{ik} is absolutely convergent" must not be taken to refer to Σc_{ik}. Some examples like Cazzaniga's would emphasise the contrast between these rules and the four rules of art. 10 (for multiplying normal determinants).

On several grounds it is regrettable that chapter x. is not more complete. No proof is given that the value of a normal determinant is the same, wherever the origin may be taken on the principal diagonal; and various analogies with finite determinants are omitted.

A new chapter (vii.) has been inserted, containing the simpler theorems on *Elementartheiler* of determinants; this term is translated literally *elementary divisors*, although several English writers have used *invariant-factors* as the equivalent. The treatment follows Dr. Muth's book very closely; we have explained elsewhere (*Bulletin* Amer. Math. Soc., vol. vii. p. 308) that some changes in Dr. Muth's order might make the work more readable. But, in default of any English text-book, we must welcome this chapter as a useful introduction to the subject.

Frobenius's calculus of bilinear forms is explained

[1] "A sequence A_n converges if $\lim_{n=\infty}(A_{n+p}-A_n)=0$, for all positive integral values of p." In this test, *p must be free to vary with n*; for instance, if A_n is log n, and p is *fixed*, the limit is zero, although the sequence diverges.

in arts. 1–9 of chapter xiv., but more use might have been made of the method. Applications may be found in the theory of orthogonal substitutions (xiv., 19, 24) and in "the equation of secular inequalities" (xi., 19). The expression given in xiv., 7, does not correctly represent the square-root of a bilinear form; in fact $[\chi(x)]^2 - x$ is not divisible by $\psi(x)$, the last equation on p. 185 being wrong. The right value will be found in Muth's book (pp. 37, 38); see also *Proc.* Camb. Phil. Soc., vol. xi. p. 81.

The reduction of a quadratic form to squares (xiv., 10) may prove misleading, for it is natural to suppose that the reducing substitution belongs to the same *unitary* type as those in the article quoted (vii., 10). But this inference is not usually correct; thus $2x^2 + 2xy + 2y^2$, which has the matrix $\begin{pmatrix} 2, & 1 \\ 1, & 2 \end{pmatrix}$, *cannot* be reduced to the form $\lambda(ax+by)^2 + \mu(cx+dy)^2$, where λ, μ, a, b, c, d are *integers*. It is remarkable that a corresponding reduction *is* possible for an *alternate* form; this contrast might be mentioned. We are surprised that Weierstrass's theorem on equivalence of bilinear forms is not stated, although Kronecker's theorem (xiv., 8, 9) is proved; the latter can hardly be appreciated without the former.

Instead of the bibliographical list which closed the first edition, Mr. Mathews has given a brief historical note. It would have been better to add some references in the course of the text, for, even with a bibliography at hand, it is often difficult to identify the original sources from which extracts have been taken.

T. J. I'A. B.

A MANUAL OF MEDICINE.

A Manual of Medicine. Edited by W. H. Allchin, M.D., London, F.R.C.P. Vol. v. Pp. xii+687. Plates ii.; charts and diagrams. (London: Macmillan and Co., Ltd., 1903.) Price 10*s.* net.

THE volume before us is the fifth of Dr. Allchin's manual of medicine, and is devoted to diseases of the digestive system, the liver, the peritoneum, the vessels of the abdomen, the kidneys, and the ductless glands.

The volume begins with two short articles by the editor upon the normal anatomy of the alimentary canal and the physiology of digestion. These articles seem to be well up to date, and in the former due importance is attached to the surface anatomy of the parts, so important to the clinician. It is, however, rather to be regretted that in the physiology of digestion no mention is made of the recent work upon pancreatic secretion. These articles are immediately followed by one on food and diet by Dr. R. Hutchinson. In twenty pages, only the merest outlines of this subject could be discussed, and the value of articles so condensed is open to question; the principles, however, of dietetics and the chemical composition of the most important food-stuffs and food preparations are given. A useful note upon the bacteria of the alimentary canal, with some suggestions concerning the therapeutic use and actions of so-called intestinal antiseptics, is written by Dr. Lazarus Barlow.

The following eighty pages are devoted to diseases of the mouth, tongue, pharynx and œsophagus, an account of these being supplied by Dr. Bertram Abrahams. These diseases are treated in a comprehensive and systematic manner. We would draw special attention in this connection to the parts of the article devoted to throat complications of acute infectious diseases and the differential diagnosis of acute sore throat. The practitioner will find these sections exceedingly useful. The next section of the work treats of diseases of the stomach and intestines, this section occupying practically 200 pages and being written by the editor. Interpolated in the above is a short account by Dr. Bertrand Dawson of the physical examination of the stomach and intestines. This includes the ordinary clinical methods and the examination by the Röntgen rays and by so-called gastro-diaphany, and also directions for the chemical examination of the gastric contents after the administration of test meals. The reviewer cannot, however, find any directions for the chemical or microscopic examination of the fæces, which might well have been incorporated. In view of recent work upon the subject, a short article by the editor upon diseases of the pancreas will be of interest.

A hundred odd pages are devoted to diseases of the liver, this subject being introduced by a general article upon the morbid anatomy of the liver by Dr. Barlow. Hepatic abscess and perihepatitis are dealt with by Dr. Crombie; degenerations, new growths and gall-stones by Dr. Hebb.

The next section of the book treats of diseases of the peritoneum, and it is also introduced by a short note on the general anatomy of the peritoneum. The consideration of retro-peritoneal suppuration and tumours and sub-phrenic abscess concludes this monograph, for which Dr. Hale White is responsible. Dr. Bryant writes a short account of the diseases of the abdominal blood-vessels, and the volume concludes by an article by Dr. Bradford upon diseases of the kidneys, and one by Drs. Sydney Coupland and Bertram Abrahams upon diseases of the ductless glands.

It will be seen from the above remarks, which amount to little more than an elaborated table of contents, that the volume before us deals very fully with the diseases of the abdominal organs. In conclusion, we may add that this last addition to Dr. Allchin's manual of medicine maintains the standard of its predecessors, and is likely to be of much value to the professional reader. Its usefulness is enhanced by a complete and accurate index.

F. W. T.

OUR BOOK SHELF.

The Racing World and its Inhabitants. Edited by A. E. T. Watson. Pp. vii+309; illustrated. (London: Macmillan and Co., Ltd., 1904.) Price 12*s.* 6*d.* net.

THIS volume, which consists of a reprint of a series of articles contributed by various writers to the *Badminton Magazine*, is essentially a work written by racing men for racing men, and as such seems admirably adapted for its purpose. An important feature is that each article is written by one who has

made the subject of that article his particular pursuit, relaxation, or study; a trainer writing on training, a breeder on breeding, and so on. Under Mr. Watson's able editing, all these diverse factors have been woven into one harmonious and continuous whole.

To the naturalist the most interesting chapter is perhaps the one on breeders and breeding, in which the writer strongly advocates the advisability of plenty of fresh air and exercise for young horses of all kinds, as well as change of pasture. Contrary to the opinion of some of his fellows, the author firmly believes in heredity, and therefore advises the selection for breeding purposes of mares which have made a name on the turf.

As regards shape, he prefers long, low, and broad animals, but it is somewhat curious to notice that in the chapter on trainers and training the writer considers this an old-fashioned view, pointing out that "St. Simon," who was anything but a long and low horse, has done much to modify opinion on this point. It is satisfactory to learn that, according to the last mentioned writer, there is much less viciousness prevalent among racehorses than was formerly the case, this being attributed to gentler and more humane methods of training and treatment.

One other point and we must take leave of this brightly written and well illustrated volume. The point in question relates to the proper manner of drawing a racehorse at full speed. As the frontispiece of Mr. Watson's work we have a picture of a race in which the horses are represented as seen in a photograph, one of them having all four legs off the ground, and looking as though it were about to fall on its nose. In contrast to this, we have, facing p. 103, a reproduction of Herring's well known picture of "Flying Dutchman," in which the horse is represented as galloping *ventre à terre*, with the fore and hind limbs stretched out to their full extent. Obviously it is an inconsistency to have these two types of representing a galloping horse in the same work, as one must obviously be wrong. From the fact that when we draw the wheels of a carriage in rapid motion we represent the spokes as forming a continuous blur, and not as seen in a photograph, our own opinion inclines to the advisability of drawing racehorses somewhat after the old conventional manner, and not as they appear in photographs, when the postures are quite unlike the appearances presented to our eyes.

R. L.

Geologie von Deutschland und den angrenzenden Gebieten. Zweiter Teil. Lieferung i. By Dr. Richard Lepsius. Pp. 246. (Leipzig: Engelmann; London: Williams and Norgate, 1903.) Price 8s. net.

THIS part of the text elucidating Dr. Lepsius's well known geological map of Germany maintains a high level, and secures the acceptance of the book as a permanent work of reference. It is not so redolent of the country itself as is the great work on Austria-Hungary recently noticed in these columns (May 19, p. 49), but it embodies the results of extensive researches, and the individuality of the author is agreeably seen when he marshals and reviews the conclusions of those who have gone before him. The present section is of especial interest to students of metamorphic areas. The amphibolites and marbles of the "kristalline Grundlage im Erzgebirge" will recall many occurrences in our Scotch and Irish highlands. The description of the saturation of a schistose area by invading granite (p. 104), and the consequent origin of the gneissic *massif* of the Erzgebirge, will appeal to those who have sought to show that our own "Archæan" gneisses may often be of composite origin, and in places of post-Silurian age. The famous area of granulite in Saxony is dealt with from the point of view so long maintained, in other regions, by French geologists, to whom personal recognition is accorded (p. 172). Dynamic metamorphism is relegated to a relatively unimportant place, and the granulite is treated as a part of the Carboniferous granitic intrusion, making its way, under pressure of superincumbent layers, into a great dome of schists. The pyroxene-granulites and other variations arise from the absorption of diabases, quartzites, and so forth, into the invading mass. The observations of Callaway in Galway and Barrois in Brittany thus receive confirmation from the stronghold of the dynamometamorphic school.

The present part also includes a description of the sandstone area of the Elbe, with lists of Cretaceous fossils, and of the post-Cretaceous overthrust (p. 182) of granite and syenite on the right bank of the river at Hohnstein.

G. A. J. C.

Traité Élémentaire des Enroulements des Dynamos à Courant Continu. By F. Loppé. Pp. vi+78. (Paris: Gauthier-Villars, 1904.) Price 2 f. 75 c.

Étude sur les Résonances. By G. Chevrier. Pp. 76 (Paris: L'Éclairage Électrique, 1904.)

M. LOPPÉ'S little book is an elementary treatise on dynamo windings which we have no doubt will prove useful to many students of this subject. The treatment is quite simple, and the mathematics required are of the most elementary nature. The book is divided into two chapters, the first dealing with bipolar and the second with multipolar machines; only ring and drum windings are discussed. There are a number of good diagrams and winding tables.

The subject of resonance in electric cables carrying alternating currents has already become of considerable importance in electrical engineering, and is likely to come still more to the front as the development of power distribution at high voltages proceeds. M. Chevrier's book is a welcome essay on the subject, as the author has endeavoured to coordinate the existing knowledge and to present the elements of both the theoretical and practical aspects in a clear manner. After a general discussion of oscillating motion, electric circuits are considered in detail, and the various cases of resonance or possible resonance in distributing mains are treated at some length.

Lehrbuch der experimental Physik in elementarer Darstellung. By Dr. Arnold Berliner. Pp. xvi+857; with plates and illustrations. (Jena: Gustav Fischer, 1903.) Price 14 marks.

THIS is an elementary but not a rudimentary treatise. The aim of the author has evidently been to present as completely as possible the fundamental principles and facts which form the groundwork of physics (including mechanics). It can be confidently recommended to any second or third year student of experimental physics who is familiar with German. The mathematics in it is of a very elementary character; the author relies, in fact, not on mathematical demonstrations, but on general descriptions aided by diagrams. Many of these diagrams are very well conceived, and materially assist the description in the text. The author is fond of the use of analogies, and we think him very successful in employing them. We were rather surprised to find the Boer war figuring as one of these analogues.

The book will be found most useful to those students whose mathematical knowledge is only slight. The medical student has, in fact, been kept in view in its elaboration.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Octopolarity and Valence.

OF the elements and their compounds there is a general property which is related to the peculiarities of their periodicity in a remarkable manner. This property is that of crystallisation, and in the isometric system is seen in its least complicated form. Among the conceivable causes which might act to produce the regular arrangement of particles evidenced in crystals, the view that considers the atom as having eight fields of polarity radiating from it, corresponding to the eight corners of a cube or the eight faces of an octahedron, agrees well with a wide range of facts. When an isometric crystal is heated and cooled under suitable conditions, polarity is developed in this manner. Four of the centres of polarity are positive and four are negative; the angle between the direction of like poles is 109° 28′.

Consider the bonds of chemical affinity or valence in the first two series of the elements. Helium, the first element of the periodic table proper, is devoid of affinity to combine; the valence of lithium, the first member of the first series, is one, of beryllium two, of boron three, and of carbon four. From stereochemical considerations it is believed that the four bonds of affinity in carbon are alike, and are disposed about the centre of the atom at angles of 109° 28′ apart, as are the four portions of the isometric crystal that have the same polarity. In the first four members of the series there is a regular increase of one bond of affinity to each succeeding element, and all are of the same character. In the next member, nitrogen, the valence is five, but one is of a different character, while four are alike in all respects as in compounds of the type NH_4Cl. Nitrogen forms compounds also on another type of valence, as in NH_3, where it is trivalent. These three bonds of affinity are of the same character. Two bonds of opposite character, one positive and one negative, are rendered latent, a self-balanced pair. Oxygen, the next member, has only two active bonds and also latent pairs, but these are more difficult to render manifest than those of nitrogen. Fluorine has one active bond of affinity, and gives some evidence of possessing latent pairs also. The valence of neon, the last member of the series, is zero, being similar to helium. The next series of eight, Na, Mg, Al, Si, P, S, Cl, and A, corresponds perfectly in regard to the number of active bonds of affinity with the preceding series, while the latent pairs are more easily rendered manifest in combination, with the exception of argon, which has not been made to enter into chemical union. The series exhibits these valencies:—

Na_1	Mg_2	Al_3	Si_4	P_5	S_6	Cl_7	—
				P_3	S_4	Cl_5	—
					S_2	Cl_3	—
						Cl_1	—
							A_0

Thus the arrangement of the pyroelectric poles of an isometric crystal may serve to illustrate the changes of valence of the elements with increment of atomic weight. It would seem that when all eight polar faces have received the increment there is perfect balance, and the structure is no longer chemically active, as in helium, neon, and argon. Each of the first four members, Na, Mg, Al, and Si, has a definite valence which does not change, while P, S, and Cl have, beside the maximum valence, 1, 2, and 3 pairs respectively which can be rendered latent in pairs, as a positive field of force neutralising the effect of a negative field.

With this clue as to the nature of the increment of atomic weight, a conception of the structure of the atom can be formed which presents many remarkable and unexpected points of agreement with the system of the elements. If the increment of atomic weight or the principal factor of increment is due to addition of a ring, and no other structure be found to adapt itself, the original atom form will consist of eight rings arranged like the eight circles inscribed on the faces of an octahedron. That rings will unite to form this as a structure of maximum stability will depend on their possessing the following properties. The material of the ring is a conductor of electric current, and a field of magnetic force permeates the space about the ring. The magnetic field on one side of the ring plane is of opposite polarity to that of the other side. The ring is elastic, and in vibrating would have a number of equidistant non-vibrating nodes about its circumference, separated by internodes of vibration. Briefly it is an elastic, current-bearing ring in rapid motion. After examining all conceivable combinations of this ring, it became apparent that the structure of maximum stability resulting from combination of these rings is that of eight rings arranged like the eight circles inscribed on the faces of an octahedron. The essential condition of stability is that contact of rings should be at non-vibrating nodes, otherwise the energy of vibration would drive them apart, also that the flow of electric current in contiguous rings should be in the same direction in each ring at the point of contact, otherwise there would be magnetic repulsion.

Rings may be added to the eight-ring structure in the order indicated above from study of the crystal and the change of valence in the series, and the stability of the structure retained or even increased. As the external arrangement remains the same, the first rings are forced inward, and as more are added the further in these first rings become, but they will not be strongly vibrating like the outer rings, and so can come in stable contact at any point of the circumference.

As there would very evidently be a limit to the number of series possible, a wire model was made of rings to determine this. When eighty rings were used, forming nine series of eight members each, after the original eight-ring form, no more rings could be added. The four innermost rings had come in contact and would go no further in, being arranged like the four circles inscribed on the faces of a tetrahedron. If a free ring was laid on the surface of the eighty-ring structure, it would be first attracted strongly by the magnetic field, and instead of being held in stable combination would be driven off by vibration of the internodes of the ring where it was laid. Such a structure would spontaneously lose rings, and these liberated rings, in accordance with their properties, would form the original eight-ring structure corresponding to helium.

FRANK A. HEALY.

6811 Anthony Avenue, Chicago, Ill.

Botanical Nomenclature.

AN event of considerable importance to botanists is the publication of a new code of botanical nomenclature, prepared by a commission appointed by the Botanical Club of the American Association for the Advancement of Science. This document, which has the approval of a large number of the leading botanists of America, appears in the *Bulletin* of the Torrey Botanical Club for May, being printed in three languages. The commission proposes to move in the Vienna Botanical Congress of 1905 that the code now offered be adopted bodily, and all other articles abandoned.

In these circumstances, it must be admitted that discussion is opportune. The authors state that they have found the Paris code of 1867 unsatisfactory, because "many important principles are either not recognised, or else given altogether too meagre consideration, and that there is a want of definite and exact statement, which leads to ambiguity." While there is very much in the new code to approve and admire, it seems to me that upon certain points these very words are exactly applicable to it. Without attempting to cover the whole ground, I desire to refer to a few special points.

(1) "Names published for primary subdivisions of species are treated as subspecific names, however designated by their authors." One example given is *Zizia aurea*, var. Bebbii, Coult. and Rose. No example is given of a plant designated a form, or of mutation; are these intended to be excluded? It seems evident that many plants designated varieties are not in any sense subspecies, and so to consider

them is improper. A nomenclatural technicality should not be allowed to obscure the facts.

(2) "A subspecies elevated to specific rank retains the same name, unless the resulting binomial has been previously published." However, *Juncus acuminatus robustus*, Engelm., 1868, though a valid species, does not become *Juncus robustus*, because of *Juncus robustus*, S. Wats., 1879. Further on, we read, "A specific or subspecific name is a homonym when it has been published for another species under the same generic name. Two subspecies of the same genus shall not retain the same name." If two subspecies in a genus may not retain the same subspecific name, as I suppose is intended, though not clearly stated,[1] may a species and a subspecies do so? It appears logically to follow, though again it is not stated, that they may not. Hence in the above case of Juncus, the Watsonian *Juncus robustus* is invalid from the first, because of the Engelmannian subspecies, and there would result from the combination of these rules the dropping of the name "*robustus*" altogether, which seems absurd.

(3) "A generic or subgeneric name is a homonym when previously published, or proposed in print, for another genus." But we are not told whether the publication of a subgeneric name precludes its use in another sense for a genus, or whether when a subgenus is elevated to generic rank it is obligatory to use the subgeneric name, if it is not a homonym. These things are recognised by zoologists, and it does not seem proper for the botanists to ignore them in their code, and then do as they individually please.

(4) Names are considered identical when "mere variations in the spelling of the same word." This seems to me a dangerous rule, and illogical since it ignores the fact that names belong to the objects they designate, independent of derivation. By considering derivation, one can prove that crab and crayfish are "mere variations" of one word,[2] and most assuredly Theodore and Dorothy are one! The examples cited in the code expressly exclude differences of gender in generic names as valid distinctions, and while the specific names Greenei and Greenii (after Greene and Green) are admitted, we are not allowed *virginianus* and *virginiensis*. In this last case, I think a difference in the sense of the adjective may be detected, apart from its application to the plant. It is the same difference that is found between the statements that a man is English, and that he lives in England. One refers to quality, the other to place.

(5) Hybrids may be named like species, with the sign × before, as × *Salix capreola*. I should prefer to write *Salix* × *capreola*. The naming of hybrids in this manner seems necessary, on account of the possible instability of the combination-names. Thus *Castilleia confusa* × *acuminata*, Ckll., *Bot. Gazette*, April, 1900, p. 280, is better called *Castilleia* × *Portcrae* (a name I have long had in MS.), because the plant formerly known as *acuminata* is now called by a different name. T. D. A. Cockerell.

Colorado Springs, Colorado, May 21.

[1] It is, however, clearly indicated by an example given.

[2] Krebis, krebs, crab; krebis, ecrevisse, crayfish, and American, crawfish!

The Formation of Coral Reefs.

Seeing (Nature, April 21, p. 581) that this delicious bone of contention has once more been clawed from its resting place, I would beg editorial permission to join in discussing it.

That dead coral is soluble in warm seas is indisputable, but that solution in coral regions exceeds deposition is an issue to be tried not in a European laboratory, but on a coral reef. It is claimed that the lagoon of an atoll was excavated by solution, and that the matter removed was poured into the open sea through the reef channels. In opposition to this I reply that the central floor of a lagoon in process of excavation should present a bare surface of eroded rock like the basin excavated by a waterfall; but the middle of a lagoon floor has been shown by many observers, and especially by Mr. G. H. Halligan's boring, to consist of weed, mud, sand, and shingle. These are indications of an area of accumulation, not erosion. Let those who believe that the lagoon floor is dissolved away produce water from the seat of action heavily charged with solution!

Again, it is contended that the water flowing from the lagoon through the exit channels bears away in suspension and solution both matter excavated from the lagoon floor and matter washed by the waves into the lagoon. In denying that either is so drained away to any considerable extent, I would point out that water unarmed with sediment has no cutting power; but if the exit channels conveyed heavily charged water, the sand blast thus produced would cut to pieces every living thing in the passage. By my observations these passages are well carpeted with luxuriant life. To elucidate this important point the next biologist to report on coral fauna might be instructed to survey a main lagoon passage in detail.

If, as I maintain, the lagoon is an area of rapid accumulation from both growth and deposition, then, if no subsidence of the atoll occurs, the lagoon must in time be filled in. Every phase from a chain of islets to an atoll filled in solid is represented in the Pacific.

The destiny of every lake and pool on the earth's surface is to be obliterated by alluvium. It is here contended that the inevitable fate of a stationary atoll is the same, the only difference being that matter is poured from above into the terrestrial lake, whereas it is washed up from below into the atoll lagoon; but, as Darwin observed, while subsidence continues it will preserve to the atoll its lagoon.

Charles Hedley.

Australian Museum, Sydney, N.S.W., June 20.

The Traction of Carriages.

In reference to a letter on the above subject in your issue of July 21, the draught of a vehicle depends largely, though not entirely, upon the ratio that exists between the distance from wheel to wheel and the height of the centre of gravity from the ground. If the wheels are far apart and the centre of gravity low, the carriage is hard to draw; if the wheels are closer or the load higher, the draught is lighter.

The reason for this fact may, I think, be readily seen by the following illustration:—Let us suppose a bicycle and rider, the centre of gravity four feet above the road, and vertically mid-way between the wheels. For the present purpose we will disregard the effect of springs and of speed. If the front wheel goes over a stone, say, two inches high, the centre of gravity, or load, is partly lifted vertically and partly thrown back over the hind wheel, describing, with relation to the machine, part of a circle having its centre at the point where the hind wheel touches the ground; and if the wheels are four feet apart, centre to centre, the load is raised about half an inch and moved backward to a much greater extent.

But we can imagine a bicycle of the same weight and having the same load with wheels, say, forty feet apart, and if this machine meets the same obstacle the load will be lifted nearly a full inch, the back-throw being scarcely perceptible; or, on the other hand, we may conceive of a bicycle with wheels four feet apart and the centre of gravity forty feet high, in which case the two-inch stone will scarcely lift the load at all, but only send it (dangerously, no doubt) back over the hind wheel.

Heavy draught depends upon, or is caused by, having to lift the centre of gravity rapidly, and may be lightened by easy springs, large wheels, putting the load high, or putting the wheels near together. Cecil G. Saunders.

Tower House, Canonbie Road, Forest Hill, S.E., July 25.

The Word Cingalese.

On p. 131 of the current volume of Nature, the expression "Cingalese fishes," and on p. 78 of the same volume the expression "Cingalese outlier" are found. The word Cingalese is also used in the "Cambridge Natural History" (Mollusca) to denote a subregion. In the first place the word should be spelt Sinhalese, the form above quoted being a quite incorrect transliteration. In the second place, the adjective corresponding to Ceylon is Ceylonese, the word Sinhalese meaning "of or belonging to the Sinhalese race."

Ceylon, July 6. A. K. Coomaraswamy.

Residual Affinity.

If Mr. Pickering has imagined that fractions of a charge are necessary, and has not discriminated between fractions of a charge and fractions of a bond, it is not surprising that his contribution of thirteen years ago failed in impressiveness. Oliver Lodge.

AMERICAN EXTINCT VERTEBRATE ANIMALS.[1]

SINCE the foundation of a department of vertebrate palæontology in the American Museum of Natural History in 1891, the curator, Prof. H. F. Osborn, and his assistants have made some most remarkable contributions to our knowledge of the extinct vertebrate animals of North America. The published work of the first six years was collected in one volume at the end of 1897, and the still more numerous papers contained in the museum *Bulletin* during the last six years have just been bound together in a second volume, which is now issued for sale or exchange. Since 1897, five large quarto memoirs on extinct Reptilia and Mammalia have also appeared under the same auspices. All these publications are illustrated both by photographs and by excellent drawings, which not only explain the technical points of the descriptive letterpress, but are also in many cases beautiful works of art.

The pioneer explorations of Leidy, Marsh, and Cope in the arid regions of the west, where the rocks are not obscured by vegetation, revealed more or less in-

FIG. 1.—Restoration of Four-toed Horse (Protorohippus) from the Lower Eocene of Wyoming.

complete evidence of the evolution of several groups of land mammals. Their work is now ably continued by the American Museum in the more favourable circumstances which result from the spread of civilisation and railroads in the remote territories where the fossils occur. Instead of making hurried forays with an armed escort, the explorers are now able to collect at leisure and make detailed observations of the rocks. Photographs are taken of all the important sections and diggings, and notes are made to determine the exact geological position and relative age of all the skeletons collected. The succession of extinct animals in western North America is thus being gradually determined with certainty, and rests less on inference than formerly. The fossiliferous deposits themselves are also better understood, and some of the earlier conclusions as to their origin have been considerably modified by these later researches. For instance, it appears from Dr. W. D. Matthew's work in connection with the American Museum that many of the famous bone-beds in the west are not contained in the sediments of old lakes of immense extent, but are largely wind-borne, and have accumulated on plains where there were varying swamps, pools, and wandering streams.

While adopting these careful methods of collecting, the American Museum has recently, with the aid of a generous donation from Mr. William C. Whitney, devoted special attention to the ancestry of the horses. Since 1899 expeditions have been sent out each year into the various Tertiary regions to collect fossil horses, and the result is that the volume now before us contains some of the most important contributions to this test-case of evolution that have hitherto been published. It is curious that although remains of horses were dug up and recognised in America so long

FIG. 2.—Rear view of Skeleton of Three-toed Horse (Hypohippus) from the Middle Miocene of Colorado.

ago as 1826, no complete fossil skeleton had been found until Mr. J. W. Gidley quite lately discovered that of the *Equus scotti* in the Lower Pleistocene of Texas. His collection now in the American Museum comprises satisfactory remains of many individuals, and makes it possible for the first time to realise the exact nature of the true horses which were once so abundant on the North American continent, and strangely became extinct before the dawn of history. A complete skeleton of a three-toed horse (*Neohipparion whitneyi*) is also described by Mr. Gidley from the Upper Miocene of South Dakota, and another nearly similar complete skeleton (Fig. 2) was discovered by Mr. Barnum Brown in 1901 in the Middle Miocene of Colorado. These remarkable fossils are mounted in the American

[1] "Fossil Vertebrates in the American Museum of Natural History Department of Vertebrate Palæontology." Vol. ii. Articles collected from the American Museum *Bulletins* of the years 1898–1903. With a preface by Henry Fairfield Osborn, Curator.

Museum with the older ancestral skeletons and feet obtained from the Cope collection and other sources, and the whole series is described in a popular manner by Dr. W. D. Matthew in an admirable small handbook which can be purchased by the visitor. The interest of the general public in the "dry bones" is also roused by some attempted "restorations" of the various animals as they appeared when alive, Prof. Osborn having secured the services of a skilful artist, Mr. Charles R. Knight. As an example of this popularisation, we reproduce the life-like drawing of the ancestral four-toed horse, Protorohippus (Fig. 1).

Prof. Cope's well known researches on the ancestry of the camels and llamas, which were originally North American animals, have been extended by Dr. Wortman, and he devotes one of the most important papers in the volume now before us to this subject. He and Dr. Matthew also treat of the ancestry of the dogs, while Prof. Osborn himself not only deals with the evolution of the rhinoceroses, but likewise with that of the Amblypoda—the small-brained herbivores of the Eocene period which eventually became bulky and developed fantastic horns when on the verge of extinction. It is curious that the extinct rhinoceroses of North America never developed a horn, except, perhaps, an incipient trace in one species. It is also remarkable that in some of the earliest normal and hornless Amblypoda (Coryphodon) Prof. Osborn is able to discover slight indications of a bony thickening where the horn-cores were destined to grow in the later members of the race.

Numerous primitive small-brained carnivores (Creodonta) are described and discussed by Drs. Wortman and Matthew, and a new classification by the latter author advances far beyond any scheme previously published. These animals are very important, because they are not only to be regarded as the ancestors of the higher Carnivora, but are also closely related to the marsupials of the Australian region and South America. The North American specimens appear to be abundant, and many are especially well preserved. Collections like those made by the American Museum are thus of more scientific value than the fragmentary remains with which palæontologists have hitherto been obliged to remain content in the Old World.

Among the remains of true Carnivora discovered by the American Museum expeditions, one of the most interesting is a gigantic skull, 18 inches in length, found with a few other bones of the skeleton in the Upper Miocene of Texas. This specimen evidently belongs to a massive animal which is neither a bear nor a dog, but something intermediate between the two. Dr. Matthew compares it with Dinocyon from the Upper Miocene of France, and describes various fragments of allied genera. It now appears that the late Prof. Cope was referring to a jaw of one of these animals when he made the announcement some years ago of the discovery of a fossil hyæna in North America. There is still no evidence of hyænas in the New World.

The ancient American lemurs form the subject of an elaborate technical paper by Prof. Osborn. The possible earliest ancestors of the rodents, from the basal Eocene, are also discussed by him. A horned rodent—the first known horned member of its order—is described by Dr. Matthew from the Upper Miocene of Colorado. This animal (*Ceratogaulus rhinocerus*) seems to have been related to the beaver, and bears a pair of bony horn-cores on the nose. There is also a paper by Dr. Matthew on the first remains of a true hedgehog discovered in North America.

The perfection of the modern methods of collecting and preparing fossils is well seen in the wonderful carapace of an extinct armadillo, *Glyptotherium texanum*, from the Lower Pleistocene of Texas. It has been known for many years that the typical South American Glyptodonts ranged northwards over the Isthmus of Panama into the southern United States before their final extinction, but no example so nearly complete as that now mounted in the American Museum (Fig. 3) had previously been obtained.

Besides Mammalia, the American Museum has collected many Reptilia, notably Dinosauria from the Jurassic of Wyoming. Since 1898 a party has been sent each year to the so-called Bone Cabin Quarry, which has proved especially rich in megalosaurian and dinosaurian remains. During the first season alone, no less than six nearly complete limbs and three fore-feet were disentombed from this spot. Since then a nearly complete skull of the megalosaurian Creosaurus, and the greater part of a skeleton of a new small and slender Dinosaur (*Ornitholestes hermanni*) have been obtained, besides less important fossils. All these are described by Prof. Osborn, and add valuable facts to our knowledge of the animals to which they belong. A well preserved skull of the horned Cretaceous Dinosaur *Triceratops serratus* is also described in much greater detail than heretofore by Prof. R. S. Lull.

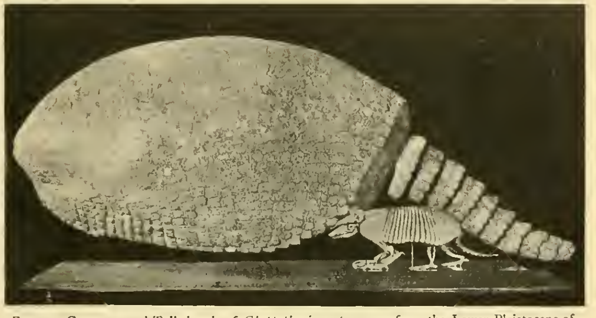


FIG. 3.—Carapace and Tail-sheath of *Glyptotherium texanum* from the Lower Pleistocene of Texas; with a modern Armadillo for comparison.

It only remains to add that the lower vertebrates are by no means neglected by the American Museum. In the present volume there are two valuable papers on Cretaceous fishes by Dr. O. P. Hay, the one dealing with American specimens in the Cope collection, the other with well preserved fishes from the fissile chalk of the Lebanon, Syria. The latter is particularly interesting as making known much new evidence of the forerunners of the saw-fishes and eels, which were almost completely developed in the Cretaceous period.

In conclusion, it must be remembered that the American Museum of Natural History is only in part a public institution. It receives only limited support from the municipality of New York and the State Board of Education. The department of vertebrate

palæontology depends almost entirely upon private munificence for the means of research. The staff is thus to be congratulated all the more on its remarkable achievements in advancing this branch of science. The collection it has mounted for public exhibition is unique as an illustration of the facts of organic evolution, and the specimens themselves have never been surpassed as examples of skilled collecting and preparation. A. S. W.

MANCHURIA UNDER RUSSIAN RULE.[1]

THIS book, dedicated to the "Gallant Japanese Nation," is a reprint of letters from Manchuria written during the autumn of 1903 for some Far Eastern publications. The narrative of events is brought down to the outbreak of war between Russia and Japan, and a "prologue" has been added to serve as a sketch of the history of Manchuria from the earliest times of which there is any record to the present day. The author is well versed in his subject, has travelled extensively in all three provinces of Manchuria, is a careful observer, and shows a sound judgment. His style is easy, and the book well worth reading from beginning to end. Indeed, we may say that it should be read by everyone who wishes to form a true opinion of the remarkable events now taking place in the Far East. For remote as Manchuria is from western Europe, its occupation by Russia, coupled with the lease from China of the peninsula of Kwan-tung, the construction of the "Chinese Eastern Railway," and the war are of great importance to the whole civilised world.

The story of this extraordinary leap in the dark of a great Power whose policy had been hitherto not wanting in prudence and foresight is well told by the author in his opening chapters. The idea, it seems, first occurred to Prince Uktomsky while accompanying the present Tsar, then Tsarevitch, in a tour round the world ten years ago. He was astonished at the success which had "attended the spread of Anglo-Saxon trade and ideas under the ægis of England's undisputed naval might," and he thought the time had come for Russia to establish an empire in the Far East. To carry out such a gigantic undertaking it was necessary to secure the services and collaboration of men of genius and untiring industry. Such a man was found in Count Cassini, the Russian Minister at Peking, whose name is associated with that of Prince Uktomsky in this vast project. "These two men," says our author, "did more than any others to set the snowball rolling down from bitter Siberia on to China."

The next step was to organise the Russo-Chinese Bank, for without this Russia could not have gained even a temporary success. M. Pokotiloff, the agent of this bank, and Mr. Victor von Grot, one of Sir Richard Hart's most valued colleagues, were entrusted with the measures necessary to ensure the credit of the Russian Government. Success at first crowned the labours of these men, and the possibilities of the future grew more and more attractive, the ultimate destruction of China and the reduction of Japan to the rank of a secondary Power being not the least important. The first blow to Russian supremacy occurred in 1895, when Japan defeated China and obtained the cession of Liau-tung. This, however, was neutralised by skilful diplomacy, and China retained possession of the forfeited territory at the price of the concession for building the trans-Manchurian Railway. By 1900 the Russo-Chinese Bank had attained the high-water mark of prosperity. But even then there were symptoms of something not being quite right, and when the following year the Russian railway administration decreed that henceforth passenger fares and freight charges must be paid for in rouble notes the whole edifice of Russian Empire in Manchuria began to totter. The defeat of the "travelling rouble" is well told by Mr. Weale—how the dollar-loving Chinaman resented the threatened loss of what he considered his birthright by the arbitrary decrees of the Russian bureaucrats, how he prepared for battle, and how finally the rouble notes, tons of which had been imported into China, were discredited and disappeared.

FIG. 1.—The Entrance to Port Arthur. From "Manchu and Muscovite."

The three chief instruments of Russia in her policy of expansion in Manchuria were the rouble, the Russo-Chinese Bank, and the railway. These three were so intimately associated and so well planned to work together that you cannot explain one without mentioning the others. In the words of our author, "they are a three-headed Medusa that turn their threatening faces on poor China and either enchant or quell her with their looks." It was becoming evident that the task Russia had so lightly undertaken was beyond her powers. She had misjudged the resistance she would encounter from the yellow race; great as her own resources were, she had over-rated these. Too confident of her strength, and relying on her successes

[1] "Manchu and Muscovite." By B. L. Putnam Weale. Pp. xx+552. (London: Macmillan and Co., Ltd., 1904.) Price 10s. net.

in overawing the native races of Central Asia, with a great faith in her destiny, she had embarked on these projects of expansion without due preparation and almost in a reckless spirit. Russia urgently requires peace, reform and retrenchment, and all these grand schemes of expansion, whether eastward to the Pacific or south to the Persian Gulf, must be abandoned. The whole system of administration is corrupt, and as long as it remains so she cannot expect to prosper, however well her soldiers fight. The lessons of this war will, it is to be hoped, turn her attention to other matters than conquest.

In the course of three years our author visited the principal towns of Manchuria—Port Arthur and its docks; Dalny, the future commercial port, upon which millions have been wasted; Newchwang; Harbin, the great railway city; Mukden, the old capital; Tsitsihar, on the Nonni; Petuna; Ninguta; and Kirin, the centre of the lumber trade. All these places are admirably described, and the incidents of the journey, whether by road, rail, or river, are amusingly told. One of the most entertaining chapters of the book is that entitled "Russia's Great Manchurian General *alias* the Chinese Eastern Railway." What this railway has cost the Russian Government will probably never be known. The author estimates it at forty-five millions sterling, though others regard this as too moderate a sum, for many accidental charges have to be added to the original cost. There were the re-laying of the rails, for these at first were far too light to resist the train weights, the changing of the sleepers, the re-building of many miles of road destroyed during the Boxer troubles, new steel-bridge work, new feeder lines, the enormous administration buildings, and stone towers for guarding the line. There were the railway, sea-going and river-steamer services, the railway barracks, the railway mines, and many other offshoots belonging to the Chinese Eastern Railway Co. The railway managed as it is can never be a commercial success, yet so rich is the country through which it passes that if properly administered and in English hands it would pay a fair return on the outlay. At present it is a frightful failure, and the best thing that could happen would be for Russia to sell the whole undertaking to Englishmen—"the only men who have been able so far to handle the Chinese with real success in trade and industry."

We learn a good deal concerning the productions of Manchuria from this book—"the greatest wheat producer in the East, the greatest lumber-field and the greatest gold mining centre." Beans constitute at present the agricultural wealth of the country, but this will not remain so for long. Manchuria is a wheat country, and flour will in a few years have taken the place of beans in the export list. The climate is described as excessively cold in winter and hot in summer, but otherwise very healthy.

BRITISH ASSOCIATION MEETING AT CAMBRIDGE.

Sectional Arrangements.

In an article published in Nature, July 21, p. 277, a general account was given of the local arrangements for the forthcoming meeting. As the main items in the sectional programmes have now been settled, it may be of interest to give a short list of papers, lectures and discussions. A new feature in the sectional arrangements this year is the increased prominence given to discussions and afternoon lectures of a semi-popular character. The number of favourable replies to the usual invitation circular received from leading men of science in Britain justifies the hope that the meeting will be a thoroughly representative one. Invitations have been issued to an unusually large number of American and foreign men of science, and in spite of the St. Louis Exhibition and other counter attractions the committee hopes to have the pleasure of entertaining about 140 guests.

Section A (Physics).

The guests include Prof. Abraham, Göttingen; Prof. Burkhardt, Zürich; Prof. Birkeland, Christiania; Prof. Dieterici, Hanover; Prof. Kayser, Bonn; Prof. Korteweg, Amsterdam; Prof. Lummer, Charlottenburg; Prof. Langevin, Paris; Prof. Leduc, Paris; Prof. MacLennan, Toronto; Prof. Pockels, Heidelberg; A. L. Rotch, Director of the Blue Hill Observatory, U.S.A.; Prof. Rubens, Charlottenburg; Prof. Sommerfeld, Aix-la-Chapelle; Prof. Voigt, Göttingen; Prof. Volterra, Rome; Prof. Wood, Baltimore; Prof. Wien, Würzburg.

The most important items will be a discussion on the radio-activity of ordinary matter, opened by Prof. J. J. Thomson, a discussion on standard wave-lengths of light by Prof. Kayser, and one on the units used in meteorological measurements. Prof. Larmor will make a communication relating to the laws of radiation; Prof. Rubens promises a paper on "Reststrahlen" and the optical qualities of metals, and Prof. Wood will contribute papers on anomalous dispersion and colour photography. Prof. Poynting will deliver a popular afternoon address on radiation in the solar system, and on the last day of the meeting Prof. Fleming will give an address dealing with some recent advances in connection with wireless telegraphy. Dr. Glazebrook is expected to give an account of some recent work at the National Physical Laboratory, and Prof. Birkeland will make a communication on the connection between solar physics and meteorology.

Section A (Mathematics).

The guests include Prof. Bendixson, of Stockholm, and Prof. Meyer, of Königsberg.

The following papers have been arranged:—Prof. Franz Meyer, die Ziele der Geometrie; Sir Robert Ball, note on a special homographic transformation of screw-systems; Major MacMahon, the theory of linear partial differential equations; Prof. A. R. Forsyth, notes on the theory of groups; Prof. F. Y. Edgeworth, the law of error; Prof. F. Morley, geometry of the complex variable; Prof. Bromwich, on the roots of the characteristic equation of linear substitutions; A. N. Whitehead, Peano's symbolic method; Harold Hilton, notes on plane curves; G. H. Hardy, Taylor's series.

There will be an exhibition of geometrical models in the large room of the Cavendish Laboratory.

Section A (Astronomy and Cosmical Physics).

Dr. H. R. Mill, on the unsymmetrical distribution of rainfall about the track of a barometric depression; Miss F. E. Carr, the application to meteorology of the theory of correlation; H. N. Russell, on the masses of the stars. Papers are promised also by Father Cortie, S.J., Dr. Lockyer, H. F. Newall, and A. R. Hinks.

Section B.

The following have accepted the invitation to attend the meeting:—Prof. Aschan, Helsingfors; Prof. Brühl, Heildeberg; Prof. Busch, Erlangen; Prof. Cohen, Utrecht; Dr. Etard, Paris; Prof. Feist, Kiel; Prof. Franchimont, Leyden; Prof. Freund, Frankfort; Prof. Guye, Geneva; Prof. Gabriel, Berlin; Comte de Gramont, Paris; Prof. Haller, Paris; Prof. Knoevenagel, Heidelberg; Prof. Meyer, Brunswick; Prof. Meyerhoffer, Berlin; Prof. Michael, Tufts College, U.S.A.; Dr. Noelting, Mülhausen; Prof. van Romburgh, Utrecht; Prof. Thiele, Strassburg; Prof. Thierfelder, Berlin; Prof. Traube, Berlin; Prof.

Tschirch, Berne; Prof. Wegscheider, Vienna; Prof. Walden, Riga; and Prof. Wollenstein, Berlin.

It is expected that the following communications will be made:—Dr. T. M. Lowry, dynamic isomerism; H. O. Jones, the stereochemistry of nitrogen; Prof. Paul Groth, on crystal structure and its relations to chemical constitution; Prof. Isidor Traube, on the velocity of osmosis and on solubility; Dr. E. A. Perman, the decomposition and synthesis of ammonia; Prof. C. Dieterici, on the energy of water and steam at high temperatures; D. L. Chapman, on the active variety of chlorine; R. S. Morrell and A. E. Bellars, the oxidation of carbohydrates by hydrogen peroxide in the presence of ferrous sulphate; R. S. Morrell and E. K. Hanson, studies in the dynamic isomerism of the α- and β-crotonic acids; F. G. Donnan, a suggested explanation of the phenomena of opalescence observed in the neighbourhood of critical series; M. le Comte Arnaud de Gramont, sur le spectre du soufre dans la photographie de l'etincelle des minéraux; H. J. H. Fenton, mesoxalic semialdehyde; note on the influence of radium radiations on atmospheric oxidation in presence of iron; a reaction for ketohexoses; H. J. H. Fenton and J. P. Millington, a colour reaction for methylfurfural and its derivatives; Prof. Ossian Aschan, on the pentavalent nitrogen atom; G. Barger, saponarin, a glucoside coloured blue by iodide; Dr. W. A. Bone and R. V. Wheeler, the union of hydrogen and oxygen in contact with a hot surface; Prof. Richard Meyer, the constitution of phthalein salts; G. T. Beilby, the intensification of chemical action in the neighbourhood of hot metals and other surfaces; reactions between solid salts.

Section C.

The guests include Dr. Ami, Ottawa; Prof. Brögger, Christiania; Prof. Bächström, Stockholm; Prof. Busz, Münster; Prof. van Calker, Groningen; Prof. Groth, Munich; Prof. Goldschmidt, Heidelberg; Dr. Rothpletz, Munich; Prof. Sjögren, Stockholm; Dr. Seligmann, Coblenz.

It is expected that the following communications will be made to the section:—B. N. Peach and G. Horne, the base line of the Carboniferous system round Edinburgh; G. W. Lamplugh, note on Lower Cretaceous phosphatic beds and their fauna; H. B. Woodward, note on a small anticline in the Great Oolite series north of Bedford; P. F. Kendall, evidence in the Secondary rocks of persistent movement in the Charnian Range; Dr. Ami, the geological resources of Canada; E. Greenly, the lava domes of the Eifel; A. Harker, exhibition of Tertiary plutonic rocks from the Isle of Rum; Prof. Busz, notes on some Cornish rocks; Prof. Bäckström, origin of the great iron-ore deposits of Lapland; L. J. Spencer, on the different modifications of zircon; F. W. Harmer, the Great Eastern Glacier; Rev. W. Lower Carter, glaciation of the Don and Dearne valleys; E. Greenly, notes on the glaciation of Holyhead Mountain; W. Whitaker, on a great depth of drift in the valley of the Stour, Suffolk, and some Cambridgeshire wells; Rev. W. Lower Carter, river captures in the Don system; Rev. O. Fisher, on the elephant trench at Dewlish, Dorset; Prof. W. J. Sollas, on the structure of the Silurian Ophiurid, *Lapworthura miltoni*; E. A. Newell Arber, on the fossil plants of the Upper Culm Measures of Devon and on derived plant petrifications from Devonshire.

There will be a discussion on the nature and origin of earth movements, opened by the president (A. Strahan), Dr. Teall, Prof. Sollas and G. Horne. Dr. Marr will give a lecture on the geology of Cambridgeshire.

Section D.

Acceptances have been received from the following zoologists:—Prof. Boveri, Würzburg; Dr. Calkins, New York; Prof. Hubrecht, Utrecht; Prof. Keibel, Freiburg; Prof. Minot, Cambridge, U.S.A.; Prof. Osborn, New York; Dr. Przibram, Vienna; Prof. W. B. Scott, Princetown; Prof. Max Weber, Amsterdam; Prof. Ramsay Wright, Toronto; and Prof. E. B. Wilson, New York.

On Thursday afternoon Prof. Osborn, of New York, will open a discussion on recent contributions to the evolution of the horse. The discussion will be continued by Prof. Cossar Ewart and Prof. Ridgeway. On Friday there will be a discussion on heredity, in which the following have promised to take part:—The president (W. Bateson), Miss Saunders, and Messrs. A. D. Darbishire, Hurst, Biffen, Doncaster, Lock and Staples-Browne. In connection with this discussion there will be an exhibition of animals and plants in illustration of the several contributions. Monday morning will be devoted to a joint discussion with Section K on the significance of the reduction division of the nucleus, in which Profs. Calkins, E. B. Wilson and others are expected to take part. In the afternoon of Monday Prof. Przibram and Mr. Brindley will open a discussion on regeneration and asymmetry. Mr. Keeble will deliver a popular lecture on the coloration of marine Crustacea. On Tuesday afternoon Dr. C. W. Andrews will give a lecture on Egyptian Eocene vertebrates and their relationships, particularly with regard to the geographical distribution of allied forms.

The sectional programme includes also papers by Prof. Keibel and Prof. Calkins on the Cytoryctes, the protozoan said to be the organism of small-pox; G. H. F. Nuttall, on the precipitation tests in the study of animal relationships; Prof. Graham Kerr, on the African collections of the late J. S. Budgett; J. W. Jenkinson, on the origin of the cleavage centrosomes in the axolotl egg; J. H. Bryce, on the histogenesis of the blood of the lepidosiren larva; Prof. Elliot Smith, on Loos's researches on Ankylostoma (the miner's worm), which he has studied in Egypt.

Section E.

The foreign visitors include M. de Déchy, Odessa; Prof. Hettner, Heidelberg; and Dr. Wind, Utrecht.

Popular afternoon lectures will be delivered by Mr. A. Silva White on scenes and sketches of life in the Nile Valley, and by Dr. Tempest Anderson on the Lipari Islands and their volcanoes. The list of papers includes the following:—(*a*) *Travel*: Major Burden, people and places in Nigeria; A. W. Hill, a journey round Lake Titicaca; Colonel Delmé Radcliffe, surveying in Western Uganda; Dr. von Drygalski, the German Antarctic Expedition. It is hoped that Mr. Bruce, of the Scottish Antarctic Expedition, may be able to attend the meeting. (*b*) *Historical Geography*: Rev. H. S. Cronin, Ptolemy's map of Asia Minor, methods of construction; D. G. Hogarth, Cyrene—an illustration of the bearing of geography on history; C. R. Beazley, the first true maps (Portolani of the early fourteenth century); Rev. A. Hunt, the site of the battle of Brunanbush (Lincolnshire) in the tenth century; H. Yule Oldham, changes in the features of the Fen district. *Physical Geography*: M. Déchy, the glaciers of the Caucasus; M. C. Rabot, glacier-bursts; Dr. H. R. Mill, a new physical map of Great Britain; Prof. Yapp, vegetative features of the Fen district; F. J. Lewis, botanical survey of parts of Westmorland; R. T. Günther, changes in the coast-line in the Bay of Naples. There will also be a paper by Major Close, R.E., on recent improvements in survey methods.

Section F.

The following have signified their intention of being present:—Prof. Dietzel, Bonn; M. Yves Guyot, Paris; Dr. Körösi, Budapest; Prof. Lotz, Munich; Prof. Mahaim, Liège; Dr. Mandello, Budapest; Dr. Pierson, the Hague.

The following papers have been arranged in connection with this section:—Prof. Flux, on improvements in agriculture and their effect on economic rent; Prof. Edgeworth, a moot point in the theory of international trade. Friday, August 19, will be devoted to a discussion on the theory and practice of foreign trade at home and abroad. Contributions will be made by Prof. Dietzel, Prof. Lotz, M. Yves Guyot, and L. L. Price. It is hoped that most of the leading English economists will be present. On Monday Mrs. Bosanquet will read a paper on the economic importance of the family, and there will possibly be a communication on cotton-growing in the Empire. In the afternoon of Friday, August 19, some members of the section will visit the Garden City near Hitchin. Among other papers may be mentioned those by J. A. Baines, distribution of rural population in India; T. C. Horsfall and Mrs. Fisher, on the housing question, and possibly a communication on some allied questions by His Excellency Dr. Pierson. It is expected that the programme will include the following additional items:—Prof. Mahaim, changes in Belgian wages; A. L. Bowley, measurement of national progress; C. J. Hamilton, trade unions in the United States of America; H. A. Roberts, employment of graduates; and W. G. Adams, modification of the income tax.

Section G.

Prof. Schröter, of Munich, is expected to attend the meeting. After the presidential address the most important items of the programme are a discussion on internal combustion engines, opened by Mr. C. Dugald Clark and Prof. B. Hopkinson. On Thursday afternoon Mrs. Ayrton will give a lecture on the origin of sand-ripples, illustrated by experiments which were recently shown at a conversazione at the Royal Society. On Monday, August 22, papers will be read by C. H. Merz on the use of electricity on the North-Eastern Railway and on Tyneside; A. A. Campbell Swinton, electricity from water-power; W. M. Morley and A. G. Hansard, energy losses in magnetising iron; Prof. J. A. Fleming, large bulb incandescent lamps as secondary standards of light. The following communications have been arranged for Tuesday, August 23:—Major Sir Hanbury Brown, K.C.M.G., on the Nile irrigation problem; J. H. Wicksteed, a universal testing-machine of 300 tons for full-sized members of structures; S. Cowper Coles, a new process for applying zinc to metallic surfaces; J. W. Hayward, the effects of receiver drop in a compound engine.

Section H.

The guests who have accepted the invitation to attend connected with this section include Prof. Deussen, of Kiel; Mr. Howitt, Australia; Prof. Kabbadies, Athens; Prof. Montelius, Stockholm; Prof. Schmidt, Copenhagen; and Dr. R. Livi, Rome.

The address of the president (Mr. Henry Balfour) will be delivered on Thursday at 10.30, and will deal with the theory of evolution in the material arts, as expounded by the late General Pitt-Rivers, and illustrated in the Pitt-Rivers Museum at Oxford. The same subject will be pursued by Prof. Montelius, of Stockholm, in a study of the evolution of the lotus-ornament, by Prof. Flinders Petrie in regard to the series of Roman lamps discovered in this season's excavations at Ekhnasya, in Egypt, and by Mr. R. T. Günther in a paper on the *Timaruta* charms from Naples.

Friday's session will be devoted to papers on anthropological surveys, actual and projected, in various parts of the world. Special stress will be laid by Prof. D. J. Cunningham, Mr. J. Gray, Mr. F. C. Shrubsall, and others on the practical value of such surveys of the physical characters of a complex modern population in providing data for inquiries of hygienic, economic, and even political nature; and a discussion is arranged on the best means of organising such surveys, with special reference to the work of the committee on physical deterioration, the report of which is, fortunately, now available for consideration.

Another important discussion, also set down provisionally for Friday, deals with the report of the committee on the present state of anthropological teaching.

Monday will be devoted to papers on social and religious institutions, and on folklore, and to a discussion of Sir Richard Temple's method of recording the languages of savages.

Tuesday's programme deals with recent work in Greek lands, with papers by Dr. Arthur Evans, Miss Boyd, and Messrs. Bosanquet and Dawkins, on their respective excavations in Crete; and with a demonstration by Prof. Montelius on the geometrical period in Greece. Other archæological papers deal with recent excavations on prehistoric sites in Denmark, Scotland, and elsewhere.

The papers hitherto received on points of human anatomy are of less popular interest and will probably be discussed by a subsection on one of the days of the meeting, to be announced later.

Section I.

The following American and foreign physiologists hope to be present at the meeting:—Prof. Atwater, Middletown, U.S.A.; Dr. Asher, Berne; Prof. Adamkiewicz, Cracow; Prof. Boruttau, Göttingen; Prof. Biedl, Vienna; Fräulein Bienenfeld, Vienna; Dr. Barbieri, Paris; Dr. Camus, Paris; Prof. Cavazzani, Ferrara; Prof. Dupuy, Paris; Prof. Donaldson, Chicago; Prof. Fröhlich, Vienna; Prof. Gley, Paris; Prof. van Gehuchten, Louvain; Prof. Johannson, Stockholm; Prof. Kossel, Heidelberg; Prof. Munk, Berlin; Prof. Magnus, Heidelberg; Prof. Mareš, Prague; Prof. Macallum, Toronto; Prof. Nicloux, Paris; Prof. Porter, Cambridge, U.S.A.; Prof. Stewart, Chicago; Dr. Veress, Würzburg; Prof. Verworn, Göttingen; Dr. Vaschide, Paris; Prof. Wedenskii, St. Petersburg.

The organising committee has introduced two items which it is hoped will prove of considerable interest. Prof. Atwater will give a lecture entitled "Nutrition Experiments on Man in the United States." The lecture will include an account of the laborious researches carried on at Middletown, U.S.A., under the auspices of the United States Government. The lecture will be of an entirely popular character, and Prof. Atwater will deal not only with the strictly physiological, but also with the economic aspect of the subject. He will treat of such problems as the feeding of the very poor in large cities. The second new feature will be a couple of discussions of a highly technical nature—oxidation and functional activity, and conduction and structure in the nerve-cell and nerve-arc. The discussions will be opened by Sir John Burdon-Sanderson and Prof. Langley respectively. There will also be a number of papers on physiological subjects, and on Saturday morning two sittings will take place simultaneously, one being devoted to pathology and the other to experimental psychology and the special senses.

Section K (Botany and Agriculture).

The following botanical guests are expected:—Prof. Bertrand, Lille; Prof. Borzi, Palermo; Prof. Chodat, Geneva; Prof. Czapek, Prague; M. de Candolle,

Geneva; Prof. Engler, Berlin; Prof. Errara, Brussels; Prof. Eriksson, Stockholm; Prof Fujii, Tokio; Mlle. Goldflus; Prof. Klebs, Halle; Dr. Lotsy, Leyden; Prof. Macfarlane, Philadelphia; Dr. Overton, Würzburg; Prof. Pierce, Stanford University, California; Prof. Reinke, Kiel; Prof. Schröter, Zurich; Dr. Schoute, Wageningen; Prof. de Toni, Modena; Prof. Vöchting, Tubingen; Mme. Weber van Bosse, Amsterdam; Prof. Zacharias, Hamburg.

Mr. Francis Darwin's presidential address will deal with the statolith theory of geotropism, being a discussion of the recent work on the means by which plants "perceive" the force of gravity. The semi-popular lecture, which in recent years has become one of the features of the section, will be given on Monday afternoon, at 2.30 p.m., by Dr. D. H. Scott. Prof. H. Marshall Ward and Prof. Jakob Eriksson, of Stockholm, will discuss their recent important researches on the biology of the fungi, especially the Uredineæ. The structure of the Cyanophyceæ will be dealt with by Prof. Zacharias, of Hamburg, Prof. Chodat, of Geneva, and others. Dr. J. P. Lotsy, of Leyden, has promised to give an account of the virgin woods of Java, and Prof. S. H. Vines will read a paper on the proteases of plants. Dr. F. F. Blackman will give an account, illustrated by experiments, of his important researches on assimilation and respiration; Prof. A. G. Tansley will give an address on some problems of ecology, followed by papers on various aspects of ecological botany by Prof. Engler, of Berlin, Dr. W. G. Smith, and Messrs. T. W. Woodhead and F. T. Lewis. Papers will be contributed to this section also by Profs. Czapek, Vöchting, G. Pierce, C. E. Bertrand, Dr. Margaret Stopes, Miss Sibille Ford, Prof. Hartog, Dr. W. G. Lang, E. A. Newell Arber, J. Parkin, Dr. A. Reginald Buller, Alfred P. Maudslay, Harold A. Wager, G. Barger and others.

For the first time in the history of the Association there will be a subsection devoted to agriculture, presided over by Dr. W. Somerville.

The following communications have been promised:—A. D. Hall (Rothamsted Experimental Station), the probable error of agricultural field experiments, and analysis of the soil by means of the plant; T. S. Dymond (County Laboratories, Chelmsford), the influence of sulphate as manure upon the yield and feeding value of crops, and the determination of the availability of insoluble phosphate in manures; R. H. Biffen, the improvement of wheats and Mendel's laws; R. H. Elliot, the clover mystery—a probable solution of it; Prof. Middleton, improvement of clay pastures through the agency of clovers; T. B. Wood and R. A. Berry, chemical composition of root crops.

Section L.

The visitors to this section include Dr. Anderssen, Christiania; M. Demolins, La Guichardière; Prof. Dewey, Chicago; Dr. Gallander, Orebro; Miss Laura Drake Gill, Barnard College, Columbia University, New York; M. A. Gobert, Brussels; M. Hovelaque, Paris; Dr. Hausknecht, Kiel; Miss Hazard, president of Wellesley College, U.S.A.; Miss Irwin, Dean of Radcliffe College, Cambridge, U.S.A.; Fräulein Knittel, Breslau; Prof. Mangold, Berlin; Prof. Münch, Berlin; Mme. Dick May, Paris; Miss Oakley, Montreal; Director Trüper, Jena; Fröken Whitlock, Djursholm, Sweden; Miss M. A. Willcox, professor at Bryn Mawr, U.S.A.

One of the chief debates in Section L will be on the subject of school-leaving certificates, with special reference to the scheme proposed by the consultative committee of the Board of Education. Other important subjects selected for discussion are the national and local provision for the training of teachers, and manual instruction in its broadest sense. Afternoon semi-popular talks will probably be given by A. D. Hall, director of the Lawes Agricultural Trust, on the need of scientific method in elementary rural instruction, and by Prof. Armstrong on the research method applied to experimental teaching.

The above summary is based on the facts supplied by the recorders of the several sections.

Tickets and programmes of local arrangements may now be obtained on application to the local secretaries, Emmanuel College, Cambridge.

SIR JOHN SIMON, K.C.B., F.R.S.

BY the death of Sir John Simon, which occurred on July 23, in his eighty-eighth year, this country has lost one of the leaders in sanitary science who with Chadwick and others made the Victorian period a memorable one. Simon commenced the study of medicine in 1833, when he was seventeen years old, and attended both St. Thomas's Hospital and the recently established King's College. Here he studied under Joseph Henry Green, the first professor of surgery at the last-named college, and acted as assistant to Todd in preparation for his physiological lectures. On the foundation of King's College Hospital in 1840, Simon became senior assistant surgeon, being associated with men so well known as Fergusson, Partridge and Bowman. It was in 1848 that he turned his attention to that branch of medicine in which his name became famous. The Corporation of the City of London applied to Parliament for powers to improve the sanitary administration of the City, and as the result of the passing of the City Sewers Act he was appointed Medical Officer of Health. About this time the epidemic recurrence of cholera in this and other countries began to attract attention, and in 1855 it was decided to create a Central Board of Health, for the medical officership of which Simon was selected. In 1858 the functions of the Board were transferred to the Privy Council. This position made him adviser to the Government on all sanitary and medical matters, and he continued to act until 1876, when he resigned his appointment, and on his retirement the decoration of C.B. was conferred on him. On the occasion of Queen Victoria's Jubilee in 1887 he was created a K.C.B. In 1867 he was appointed a Crown member of the General Medical Council, and took an active part in the work of that body until 1895.

The effect of Simon's work as Medical Officer of Health was far more than local; his annual reports, which cover the years 1848 to 1855, form a landmark in the history of English sanitation; they survey the sanitary condition of the City, review the risks arising from cholera and other infective diseases, detail the evils of overcrowding, and direct attention to a condition of affairs which until then had escaped notice. In 1853 he was appointed one of the commissioners to inquire into the outbreak of cholera at Gateshead and Newcastle, and in 1856 submitted a report on the outbreaks of that disease in London in 1848–49 and in 1853–54, conclusively demonstrating the dependence of these epidemics on a polluted water supply. In 1857 he published a volume entitled "Papers on the History and Practice of Vaccination," which was followed in 1858 by the "Report on the Sanitary State of the People of England," which demonstrated for the first time the wide variations which exist in the local incidence of certain diseases and emphasised the need for skilled inquiry. During his term of office under the Privy Council the results of a number of

classical investigations were embodied in his reports, *e.g.* into diphtheria, diseases of the cotton famine, pulmonary diseases, &c. In 1862–63 an important inquiry was undertaken into dangerous industries, in 1863 a survey of the hospitals of the United Kingdom. In 1865–66 he had to establish the organisation to deal with cholera, in 1871 that to deal with the great epidemic of small-pox, and in 1870 he initiated a scheme for laboratory work in public health. He was an uncompromising opponent of the useless practice of quarantine.

Simon's resignation in 1876 was brought about by the Local Government Board Act of 1871 creating the Local Government Board. In Simon's opinion large questions of medical policy affecting the whole country could only be adequately dealt with by a Ministry of Health, a view which is widely held by the medical profession at present, and, having allowed time to see how the new Acts would work, he retired discouraged and disheartened. It is true that the Medical Officer of the Local Government Board and its staff now have duties and responsibilities far wider and more numerous than they were at the date of the creation of the Board, but still a great opportunity was missed. In 1890 he published his great work on "English Sanitary Institutions."

Simon numbered among his friends many of the greatest men of the nineteenth century—Darwin, Buckle, G. H. Lewes, Kingsley, Renan, Tennyson, Rossetti, Burne-Jones and many others. He was in 1878 president of the Royal College of Surgeons, and was the recipient of numerous other honours. He has gone to his rest honoured of all men, and his name will ever live in the annals of sanitary science.

R. T. HEWLETT.

A BANKER NATURALIST.

BY the sudden death of Mr. Henry Evans on July 23 the Midlands have lost a well-known and wealthy banker, and the West Highlands of Scotland an equally well-known deer-stalker, yachtsman and naturalist. Born in 1831, he was educated at Trinity College, Cambridge, graduated there, and was a member of the Senate of the University to the end of his life, coming up from time to time to record his vote on matters of importance. Early in his career he appears to have developed a love of natural history pursuits, for while an undergraduate he became an associate of the Ray Club, of which there are only six at a time, chosen on account of some proved zeal in these studies. He took at that time to entomology, and made a collection of British Lepidoptera. Even up to the end of his life, when he had long abandoned these early predilections, he was still proud of his insect cabinet, and especially of the numerous and fine specimens which it included of the now extinct English large copper butterfly. Being the youngest son of a banker, he naturally became a partner in his father's bank, that of Messrs. W. and S. Evans and Co., of Derby, and on its amalgamation with another firm he was made a director of the new company, Crompton Evans Union Bank. But though a shrewd and capable man of business, he never mingled in public affairs. The leisure of his younger years was largely given to rifle-shooting, in which he grew to be one of the best shots in the country. He competed at the Wimbledon meetings of the National Rifle Association until a lamentable accident occurred to him at one of the practices, when the rifle of a companion was unwittingly discharged against his leg. Three successive amputations were necessitated, and he had to go up on crutches to receive a prize which he had won. This disaster, however, was not allowed to deprive him of his favourite sport. He had become an expert shot among the red deer of the Scottish forests and the seals of the coast of Connemara, and with indomitable courage he now availed himself of the help of a pony and continued his campaigns among the mountains with more success than ever. In one season he fired fifty-two shots and killed fifty deer. After renting various tracts of ground in the Highlands, he finally, in 1875, leased the forest which comprises the extensive mountain ground in the centre of the island of Jura. Choosing a tract of bare moorland that sloped down to the sea, he built there a comfortable mansion-house, surrounding it with trees and shrubs and flowers, covering it with roses, and ingeniously devising expedients that baffled the Atlantic blasts and enabled his vegetation to bloom and spread. This charming Highland retreat became his home for some months every season for nearly thirty years, and he lingered longer there as time went on until eventually he spent more than half of each year in Jura. But though deer-stalking was the original and predominant motive for these prolonged northern sojourns, he was far more than a mere sportsman. His early love of natural history pursuits found an ample field for development in his island home, but it was to the birds that he now gave his attention. Gifted with excellent eyesight, Mr. Evans was an acute and accurate observer. The rapidity and exactness of his recognition of birds on the wing were so remarkable that to friends who accompanied him it almost seemed as if he were the happy possessor of another sense beyond the number allotted to ordinary mortals. He made his mountains and moors in Jura a perfect paradise for wild birds. No gun or trap was ever allowed to be used against them, and everything was done that would induce them to frequent the district.

But it was not only in his own forest that Mr. Evans watched the habits of wild birds. He fitted out a steam yacht, the *Aster*, of 250 tons, on which he usually spent a month or two every year, cruising around the coasts and islands of the west and north of Scotland. He was thus able to gratify his passionate love of cliff scenery and his delight in the crowded breeding haunts of the northern sea-fowl. There are few precipices and inlets in the west and north of Scotland which he had not visited and about which he had not some natural history record to tell. He used to keep jottings of these observations. But he had no ambition to be an author. The retiring disposition which kept him from taking part in public affairs prevented him also from publishing any account of what he saw. All that he observed, however, was freely communicated to those whom it would interest. Some of his observations have thus been made generally known, but his numerous unpublished notes on the distribution of birds all over the west of Scotland would doubtless furnish valuable material to zoologists interested in this subject. Besides shooting his red deer in Jura, he studied them as a four-footed community living isolated under special conditions. He embodied his observations and statistics in a little pamphlet printed some years ago, but only for private distribution, and entitled "Jura Red Deer." Before surrendering his forest to the landlord he brought the records of deer-life up to the end of his tenancy and embodied them in an interleaved copy of the pamphlet. His experience had enabled him to gather together a good number of valuable facts. It is much to be desired that the completed pamphlet should be carefully revised by a competent editor and published as a

contribution to the discussion of the struggle for life among a single species on a small island.

Three years ago Mr. Evans was stricken down by what with most men would have been a fatal illness. But his strength of constitution and marvellous determination of character enabled him to recover sufficiently to be once more able to resume his voyaging in the *Aster*. Deer-stalking, however, with all its joys among the corries of Jura was no longer possible for him. Accordingly he gave up his deer-forest and purchased the beautiful estate of Ascog, in Bute, which he immediately set about to alter and improve. At the end of June last he started with a few friends on what proved to be his longest and last cruise. Under pleasant conditions of weather he visited all his favourite haunts—the cliffs of Mingulay and Barra Head, the sea-lochs of the chain of the Outer Hebrides, the precipices of St. Kilda with their vast swarms of sea-fowl, the fjords of western Sutherland, the cliffs and inlets of Orkney, and the voes and furthest islets of Shetland. In many of these places the *Aster* was a familiar visitor, and was received with blowing of horns and other signs of welcome. At St. Kilda the villagers ran up their flag, and half the population came out in a couple of boats to see their old friend and benefactor, who never failed to bring them some token of his thoughtful interest in their welfare. The cruise was successfully completed by the return of the yacht to Oban, but before the final day, which was to include the rounding of the Mull of Cantyre and the passage up the Firth of Clyde to Bute, it was resolved to anchor opposite the old Jura home and to spend there the following Sunday (July 24). Mr. Evans had been remarkably well all the voyage, and was delighted to have successfully accomplished all that he had wished to do. On reaching Jura he went ashore for a short walk along the coast-road. He had hardly landed, however, and was in the act of conversing with an old gamekeeper who had come down to greet him when he dropped dead as he sat. His retiring modesty kept him from making many friends, but his frank and kindly nature and his vein of quaint humour endeared him to the restricted circle that was privileged with his friendship. He will be mourned by many a lowly family in the west of Scotland that has good reason to remember his cheery greeting and his generous help. He has left a benefaction to the museum of Cambridge University, which has already been enriched by valuable contributions from him in his life-time.

A. G.

NOTES.

CAPTAIN ARTHUR MOSTYN FIELD, R.N., has been appointed successor to Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S., as hydrographer to the Navy, the retirement of Sir William Wharton having taken place on Monday last.

THE next annual meeting of the British Medical Association will take place in Leicester, the president-elect being Mr. G. C. Franklin, senior surgeon to the Leicester Infirmary. The council of the association will recommend that the meeting in 1906 be held in Toronto.

THE next session of the American Medical Association will take place from July 11 to 14, 1905, at Portland, Oregon, under the presidency of Dr. Louis S. McMurtry, of Louisville, Kentucky.

THE Board of Estimate of the City of New York has voted the sum of 2000*l.* towards an investigation by a commission of medical experts as to the contagious nature or otherwise of pneumonia.

THE FitzPatrick lectures at the Royal College of Physicians for the present year will be delivered by Dr. J. Frank Payne on November 8 and 11, the titles being respectively "Gilbertus Anglicus and Medicine in the Anglo-Norman Period," and "Ricardus Anglicus and the History of Anatomy in the Middle Ages." The Bradshaw lecture will be delivered on November 15, the lecturer—Dr. F. F. Caiger—taking as his subject "The Treatment of Enteric Fever."

THE following lecture arrangements for 1905 have been made in connection with the Royal College of Physicians:—The Goulstonian lecturer will be Dr. W. C. Bosanquet; the Milroy, Dr. T. M. Legge; the Lumleian, Dr. W. H. Allchin; the Oliver Sharpey, Dr. L. E. Hill; the FitzPatrick, Dr. Norman Moore

AN American Society of Tropical Medicine has been started in Philadelphia. Dr. T. H. Fenton is the first president, and a number of men of science who have made researches in the prevention of tropical diseases have been elected honorary members. Among the latter we notice the names of Sir Patrick Manson, F.R.S., Dr. C. J. Martin, F.R.S., and Prof. R. Koch.

JOHNS HOPKINS UNIVERSITY is, it is reported, about to undertake systematic work on the subject of tuberculosis. Mr. Henry Phipps, of Pittsburg, has given the sum of 4000*l.*, by the help of which a dispensary building is to be erected so arranged that the treatment of patients may be attended to and the disease investigated.

A REUTER telegram published in the *Times* states that according to a private telegram published by the *Verdens Gang* from Finaes, in Finland, the captain of a vessel from Tromsö reports having found a bottle containing a letter sent off from M. Andrée's Polar balloon expedition. The bottle, which was picked up on a small island north of Spitsbergen, contains a letter bearing a date in 1898. Particulars as to the contents of the letter will not be available for another month. A private telegram from Finaes published by the *Landsblad* says that the bottle was found on the island of Moffen, to the north of Spitsbergen.

A BOARD of Agriculture has recently been established in the Bahamas, and a botanic station is to be started in connection with it for which a curator will be required. Applications for the post should be made in the first instance to the Imperial Commissioner of Agriculture for the West Indies, Barbados.

THE Barker anatomical prize of thirty guineas has been awarded to Mr. Charles Cooper, a student in the Royal College of Surgeons, Dublin. The prize is offered annually, and is open to all students in any medical school in the United Kingdom. This is the fifth successive year the prize has been conferred on a student of a Dublin college.

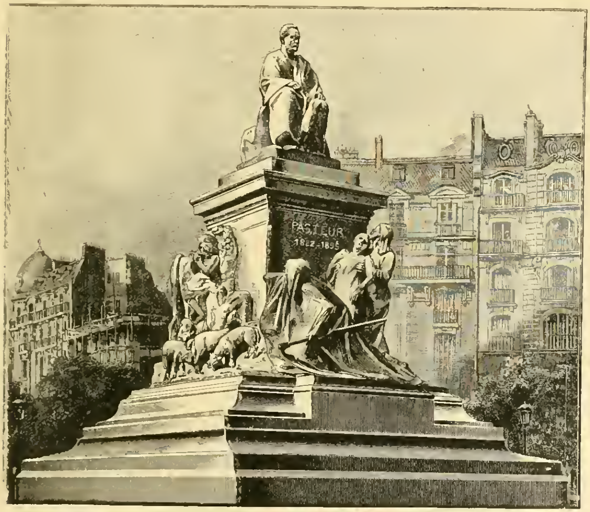
THE St. Bartholomew's Hospital testimonial to Mr. Alfred Willett will, says the *Lancet*, take the form of a silver medal to be known as the "Willett medal," which will be awarded each year to the candidate obtaining the highest marks in operative surgery in the Brackenbury surgical scholarship. A gold medal of the same design will be presented to Mr. Willett.

THE death is announced of Prof. Simonds, formerly principal of the Royal Veterinary College, and consulting

veterinary surgeon to the Royal Agricultural Society. Prof. Simonds made many researches into the diseases of animals, and became professional adviser to the Privy Council in all matters relating to the regulations and supervision of the cattle trade.

According to the *Scientific American*, the patents of the De Forest and Maskelyne wireless telegraphy systems have been amalgamated. The object of the combination is the employment of wireless telegraphy as a feeder for cable telegraphic systems. In cooperation with the cable companies, it is proposed to link isolated islands with the nearest cable stations, and to develop wireless communication between ships and shore, and between vessels at sea. This combination will, it is thought, strengthen both systems. The De Forest apparatus is a sound recorder, the messages being received on the principle of a telephone, while the Maskelyne system is a tape recorder. By this amalgamation, therefore, either system will be available according to requirements.

Falguière's monument to the memory of Pasteur was, as announced in Nature of July 21, unveiled in Paris by President Loubet on July 16. The monument is the result of an international subscription, and may be regarded as a world-wide tribute to the memory of a great man of science. The illustration, reproduced from *La Nature*, serves to convey an excellent idea of the memorial. The whole monument is about seven metres in height, of which a little more than four metres form the pedestal. Pasteur is shown seated and in deep thought. Beneath the statue round the pedestal are grouped allegorical figures which recall very naturally the successive discoveries made by Pasteur. On the front face of the pedestal occur the words "Pasteur 1822–1895," and underneath the inscription "Ce monument est dû à une souscription internationale."



A statue to Jan Pieter Minckelers, the reputed discoverer of coal gas, was unveiled last month in Maastricht, Holland. Minckelers was born in 1748, and became in 1772 professor of physics in the University of Louvain, where in 1784, in endeavouring to discover a substitute for hydrogen, he succeeded in obtaining from the distillation of powdered coal a gas which he called "inflammable air." It was in 1785 that he first utilised the gas for lighting purposes, when a class-room in the Louvain University was illuminated by his method. He died in 1824 at the age of seventy-six years.

The first annual convention of the British Foundrymen's Association was begun on Tuesday last at Manchester, when the president, Mr. Buchanan, delivered his inaugural address. Papers on the structure of metal and alloys, illustrated by photomicrographs of types of cast iron, steel, brass, and bronze, used in foundry practice, by Mr. Percy Longmuir (Carnegie medallist), and strength tests of cast metals, by Mr. W. T. MacCall, were read and discussed, and on Wednesday visits were paid to some industrial centres.

Several parts of Paris being so infested with mosquitoes, the matter of their suppression has been considered by the Conseil d'Hygiène et de Salubrité de la Seine, which, according to the Paris correspondent of the *Lancet*, recently adopted certain conclusions of which the following is a summary:—In the first place stagnant water where their eggs are hatched and localities where the insects collect, such as cellars, sewers, and dark places, ought to be kept under observation. Drains and sewers of all kinds, and the openings of the pipes which supply water in the streets, should be regularly inspected to avoid collections of stagnant water, and insects assembling in numbers should be destroyed either by a burning torch or by lime-washing. Roofs and rain-water gutters ought to be examined, and water ought not to be allowed to lodge in the gutters. Nothing capable of holding water should be placed in front of windows, and places which are the haunts of mosquitoes should be well ventilated. Stagnant water should not be allowed to remain in gardens and courtyards. Fountains and basins in public places should be emptied and cleansed at least once a week, and plenty of fish should be kept in large sheets of water. In basins and casks standing on private ground there should be a layer of petroleum oil on the surface of the water (about a gram per square metre), or if the water contains fish a layer of salad oil. The public should be advised to use mosquito curtains. Mosquito bites should be treated with a drop of tincture of iodine or with a drop of a solution of guaiacol of 1 per cent. strength.

According to the *Lancet*, Dr. W. H. Symons, medical officer of health, Bath, has completed a geological model of the City of Bath and the surrounding district covering an area of 36 square miles. The horizontal scale is six inches to the mile, and the vertical scale is six inches to 1000 feet. The model has been placed in the museum of the Royal Literary and Philosophical Institution of the city.

Prof. Schäfer, F.R.S., describes a simple and efficient method of performing artificial respiration in the human

subject, especially in cases of drowning (*Med. Chirurg. Trans.*, vol. lxxxvii.). Immediately the patient is recovered from the water he is placed face downwards, the head being turned sideways so that the mouth and nose are unobstructed, with a folded coat under the lower part of the chest; if respiration has ceased every instant of delay is serious. The operator then places himself athwart, or on one side of, the patient's body in a kneeling posture and facing the head. He places his hands flat over the lower part of the back (on the lowest ribs), one on each side, and gradually throws the weight of his body on to them so as to produce firm pressure—which must not be violent—on the patient's chest. This compresses the chest, and air (and water if there be any) is driven out of the patient's lungs. He then raises his body slowly so as to remove the pressure, still keeping his hands in position. This process of applying pressure and of relaxation of pressure by the forward and backward movement of the operator's body is repeated every four or five seconds without any marked pause between the movements. This course must be pursued for at least half an hour, or until the natural respirations are resumed. If the respirations after being established tend to fail, the process of artificial respiration must again be resorted to. If there be means, others may remove the wet clothing by cutting it off, and may apply hot flannels to the body and limbs and hot bottles to the feet, but nothing should be allowed to interfere with the regular and systematic application of artificial respiration. No attempt should be made to give restoratives by the mouth until natural breathing has re-commenced. In another paper Prof. Schäfer gives the results of the experiments he has performed, showing the efficiency of his system of treatment (*Proc.* Roy. Soc. Edin., xxv., part i.).

IT has always been more or less tacitly assumed that the difficulties which attend respiration at great altitudes are due solely to the diminished tension of the atmospheric oxygen. Two papers by A. Mosso in the *Atti dei Lincei* for June 19 would tend to disprove this assumption. It is shown, in the first place, that when the barometric pressure of a mixture of oxygen and nitrogen is diminished to one-third of an atmosphere, whilst the proportion of oxygen is increased so that its partial pressure is the same as in ordinary circumstances, severe inconvenience is incurred by breathing the mixture, and an abnormal respiration and pulse frequency are produced. That this is due not merely to the increased proportion of oxygen is shown by a study of the effects produced by breathing pure oxygen on the summit of Monte Rosa. Analyses of the blood indicate that a diminution in the proportion of carbon dioxide, caused by the low pressure, is probably responsible for the result, and this view is upheld by the fact that a mixture of oxygen and carbon dioxide, containing 20 per cent. of the latter, which on being inhaled in Turin caused giddiness and vomiting was breathed with ease and a sense of pleasure on Monte Rosa.

IN a paper by G. Gallo in the same number of the *Atti* an account is given of the conditions under which tellurium can be estimated electrolytically. Previous attempts to effect the electrolytic deposition of the element have been unsatisfactory because of the powdery nature of the product. It is now shown that the presence of sodium pyrophosphate in the electrolysed solution causes the tellurium to be deposited as a firmly adherent film; when, by saturating the solution with carbon dioxide, this film is protected from oxidation, its weight corresponds with a quantitative separation.

IN the same journal for July 3 appear two papers of considerable physiological interest. In the first, by A. Mosso and G. Galeotti, it is shown that when alcohol is ingested at great altitudes, for instance at the summit of Monte Rosa, it fails altogether to produce its usual characteristic effects. There is no indication of either excitement or intoxication, and it appears that at such a height the nerve cells are no longer responsive to alcoholic stimulus. The second paper, by A. Herlitzka, deals with the self-digestion of pepsin. From the experiments described it is concluded that, as a proteid, pepsin is capable of being digested by itself to form peptone, and that this change always occurs in a warm aqueous solution of pepsin containing hydrochloric acid. A falling-off of the digestive activity with regard to other proteids is a measure of the gradual change.

IN the *Memorie* of the R. Ist. Bologna (series vi., vol. i.) Prof. Augusto Righi describes a number of measurements he has made on the radio-activity of common metals. The rate of discharge, in dry carbon dioxide gas, of an especially constructed single-leaf electroscope of small capacity was observed when the leaf was hanging immediately above a disc of the metal in question. It was found that nearly all the common metals had practically the same ionising effect as glass; lead and bismuth were exceptions, their power of rendering a gas conducting being abnormally great. The observation is of significance because particularly active modifications of lead and bismuth have already been obtained by other workers.

A FURTHER contribution to the subject of Mendelian laws by Mr. C. C. Hurst appears in the *Journal* of the Royal Horticultural Society (May), wherein he describes his experiments upon heredity in peas, undertaken with the object of repeating Mendel's original observations; an important point is the consideration of the histological difference between races, as, for instance, between *round* and *wrinkled* peas. In the same volume will be found two papers devoted to the iris. In the first Miss Armitage treats of bulbous irises for the rock garden, and of rhizomatous species for the water garden, and appends a list of phenological observations which shows that by judicious selection of species it is possible to have iris flowers continuously for eight months; the variability of the flower, and the distinction between *bearded* and *beardless* irises is the subject of an article by Mr. W. J. Caparne.

IT has been stated on good authority that more than half of the waste lands in Ireland are suitable for forest plantations, and Dr. Henry, in the course of a lecture on "Forests, Wild and Cultivated," delivered before the Royal Society of Dublin in February, advanced further arguments in favour of afforestation. He pointed out that Ireland possesses an ideal forest climate on account of the heavy rainfall, the mild climate, and the absence of cold winds in winter. To illustrate his remarks on forest management, the author took his descriptions from French practice, including plantations in the districts of the Jura and the Vosges, and in the Landes, where successful results have been obtained with a strict regard for economy.

THE Natural History Museum recently received from Osborne House two mounted heads and one skull of Spanish draught oxen, sent by command of His Majesty the King. They have remarkably fine horns, and serve to illustrate the difference between this handsome breed and the Spanish fighting bull, of which an entire specimen has been exhibited for the past few years.

To *Naturen* for June and July Dr. L. Stejneger, of the U.S. National Museum, communicates an interesting paper on the "Celtic pony" recently described by Prof. J. C. Ewart and its relation to the now extinct tarpan of the Russian steppes, and to a Norwegian breed termed the "fjordhest." All appear to be closely related, if not, indeed, identical, the tarpan and the "fjordhest," at any rate, frequently lacking the callosity on the hind limb.

Judging from the fact that the one on the brain of the sheep has reached a third edition, Dr. B. G. Wilder's "Physiology Practicums," published by the author at Ithaca, U.S.A., appear to have attained the success they deserve. Seven plates illustrate the part before us.

No interruption to the steady pursuit of science in Japan appears to be caused by the war, three parts (one of them of exceptional thickness) of the *Journal* of the College of Science of Tokyo having reached us by last mail. The first of these (vol. xviii., art. 7), which comprises no less than 307 pages of text, illustrated by 23 plates, is devoted to the fourth instalment of Dr. I. Ijima's studies on the hexactinellid sponges. In this section the author treats of the family Rossellidæ, which he divides into three sub-families. Of the other two parts to hand, one (vol. xix., art. 14) contains a study by Mr. K. Yendo of the genicula of the calcareous algas of the group Corallinæ, while the other (vol. xix., arts. 18 and 19) is devoted to descriptions of certain low plant-organisms by Mr. K. Saito.

The *Entomologists' Monthly Magazine* for August contains notes by Mr. J. R. Tomlin on Manx beetles, which are said to be of interest in respect to island faunas, while Mr. J. J. Walker, who has recently visited Melbourne, contributes a notice of his inspection of the Curtis collection of British insects preserved in the museum of that city. This collection, it appears, was purchased about 1864 from the widow of Mr. J. Curtis. According to Mr. Walker, it contains the types of several of Curtis's species or varieties—it is a pity that these should be in Australia.

The *Biologisches Centralblatt* for July 15 contains the third instalment of an article by Mr. G. Klebs on the problem of development, the author in this instance discussing the evidence afforded by the lower plants. Dr. W. Petersen concludes his essay on the value of "indifferent" characters as species distinctions, and Dr. W. Volz communicates a note on the distribution of the two species of gibbon inhabiting Sumatra.

In the *Bulletin de la Classe des Sciences* (Brussels), 1904, No. 3, M. P. Mansion directs attention to the new international language proposed by Prof. Peano in the form of "Latin without inflexions." The attempts at building up a universal language in the forms of the Volapük of Schleyer and the Esperanto of Dr. Zamenhof have both met with considerable success, but it was left for the mathematician of Turin to reduce the problem to what may be regarded as the limit of simplicity by proposing, in 1903, a modification of Latin, in which not only genders, persons, cases, and numbers are abolished, as previously suggested by Leibnitz, but even tenses and moods are no longer retained. This system would not only have the advantage of making Latin the language of the learned world, as it used to be in the middle ages, but it could be very easily introduced owing to the extent to which Latin is taught in schools all the world over.

M. E. S. London has carried out a number of experiments on the physiological and pathological actions of the radium emanations derived from 10 milligrams of radium bromide dissolved in 10 cubic centimetres of water (*Arch. d'Électricité méd.*, No. 142, 1904). Frogs and mice exposed to the emanations for 5–6 days became ill and died, hæmolysis occurred in defibrinated blood exposed for two or three days, and the vitality of bacterial cultures was destroyed after an exposure of two days. The gastric and pancreatic ferments were, however, unaffected by the emanations.

The commission consisting of Colonel Bruce, F.R.S. (chairman), Major Horrocks, Staff-Surgeon Shaw, R.N., Dr. Zammit, chemical analyst and bacteriologist to the Government of Malta, and Dr. R. Johnstone, of the Local Government Board, has begun its work of investigating the etiology and pathology of Mediterranean or Malta fever. The experimental work is being carried on at the laboratories of the Naval Hospital, of the Army Station Hospital, and at the offices of the Board of Health, Malta. The disease, says the *British Medical Journal*, is the cause not only of many deaths among sailors and soldiers, but also of much invaliding, which is all the greater owing to the prolonged course which the disease commonly runs even in cases which ultimately recover. While it is known that the disease is due to a specific microbe, the *Micrococcus melitensis*, very little has yet been certainly ascertained as to the mode in which the specific agent maintains its existence and how infection is contracted. A knowledge of these points in etiology is an essential preliminary to devising and enforcing effective prophylactic measures.

The Röntgen Society will in future publish its proceedings in its own journal, which will appear as a bi-monthly "during the working session." The first part of the *Journal*, dated July, has just reached us, and is a well produced periodical which should be of service to radiographers. In addition to four full-page process plates, a separate photogravure portrait of Prof. Silvanus P. Thompson, F.R.S. (the first president of the Röntgen Society), is issued with the number.

Messrs. Newton and Co.'s new list of X-ray and high frequency apparatus has reached us. It contains particulars of the latest forms of apparatus made by this firm, and should be seen by all workers in this branch of science.

The summer number of the *Chemist and Druggist* (dated July 30) contains an article on Sir William Ramsay and his work. The paper contains a full-page illustration showing Sir William Ramsay in his laboratory experimenting with radium. The *Scientific American* for July 23 also has a page illustration of Sir William Ramsay in his laboratory, the original photograph of which was specially taken for our American contemporary.

Several of the August issues of the monthly magazines that have reached us contain articles dealing with subjects of a more or less scientific character. Thus *Chambers's Journal* has a contribution entitled "A Visit to a Wild-Animal Farm," the farm in question being that belonging to Mr. R. Leadbetter in Buckinghamshire, and known as Hazlemere Park; *Good Words* contains an appreciation of Stanley and a summary of the results of his work by Sir Harry Johnston; and in *Pearson's Magazine*, under the title of "Two Thousand Photographs a Second," the electro-stereo-chromophotographic camera invented by M. Lucien Bull for the photography of insects in flight is described and graphically illustrated.

OUR ASTRONOMICAL COLUMN.

THE RED SPOT ON JUPITER.—This object exhibited a slackening motion during the years from 1878 to 1900. It then became decidedly accelerated, so that the rotation period, which in 1899 and 1900 was 9h. 55m. 41·7s., decreased in 1901 to 9h. 55m. 40·6s., and in 1902 to 9h. 55m. 39·0s. In 1903 the spot again became retarded, and the rotation period increased to 9h. 55m. 41·0s. This retardation has now in turn given way to another acceleration of speed. In January last the longitude of the spot was 35°, whereas at the present time it is only 30°, so that the rotation period during the first six months of 1904 has been about 9h. 55m. 39·5s. It is difficult to explain these curious oscillations in velocity. Some extensive disturbances have, however, affected the south temperate region of the planet in recent years, and a large dusky patch has been visible since 1901 rotating with a rate of 9h. 55m. 18·7s., or about 22 seconds less than that of the red spot. The motion of the latter may possibly have been affected by disturbances occurring in the same latitude, but this can only be fully determined by further observations. In the meantime, both the red spot and the south temperate spot are being attentively watched as to their motions and appearances. The two objects were in conjunction in July, 1902, and June, 1904, and in the spring of 1906 the event will be repeated if the south temperate spot should remain visible until that time. As to the red spot and its surroundings, they appear to form features of remarkable permanency, and are likely to continue perceptible for an indefinite period.

VARIABLE RADIAL VELOCITY OF α ANDROMEDÆ AND FOUR OTHER STARS.—Whilst engaged in line-of-sight work with the Lowell spectrograph Mr. V. M. Slipher discovered the variable radial velocities of α Andromedæ, α Libræ, σ Scorpii, X Sagittarii, and ϵ Capricorni.

The velocities of α Andromedæ were obtained from measurements of the $H\gamma$ and 4481 magnesium lines, the helium 4472 line also being measurable. They range from +20 (February 11) to −45 km. (March 4), but are uncertain to a few kilometres. The observations indicate a period of about 100 days and a very eccentric orbit.

The measurements of the α Libræ spectrograms give a range between −60 km. on May 24 and +20 km. on July 6, and suggest that both components are bright. The velocities of σ Scorpii range between +25 (June 25) and −25 km. (June 18). Only two plates were measured for X Sagittarii, which is a visual variable having a period of seven days, and these gave +1 and −22 km. on June 19 and 22 respectively. A range of from −45 km. (September 7, 1903) to +6 km. (July 6) was obtained for the radial velocity of ϵ Capricorni (Lowell Observatory *Bulletin*. No. 11).

VARIOUS CLASSES OF SILICIUM LINES AND THEIR OCCURRENCE IN STELLAR SPECTRA.—In a communication to l'Académie des Sciences (Paris), M. de Gramont describes some results he has obtained during a series of experiments on the effects of various amounts of self-induction in the spark spectrum of silicium. His observations led him to form two main classes of silicium lines:—(1) those which are not affected or are strengthened by self-induction amounting to 0·03 henry; (2) those of which the intensities are reduced by self-induction and which disappear entirely with 0·006 henry.

He further divides them into eight groups (α–η), and, in a table showing their individual characteristics in the spark and in various stellar spectra, he shows their connections with the four temperature groups (silicium i.–iv.) named by Sir Norman Lockyer in his temperature classification of the stars. From this table he draws the following conclusions:—(1) Only the spectra of the first class, *i.e.* hydrogen and helium stars, show the lines which disappear under the action of self-induction, those of helium, *e.g.* the Orion stars, exhibiting as strong lines those which are first to disappear (Lockyer's silicium iii.), whilst the hydrogen stars, *e.g.* Sirius, present the lines which are the last to disappear (silicium ii.). Stellar spectra of the second class (solar type) and the "flash spectrum" contain the lines which appear in both arc and spark, and resist self-induction, *e.g.* λ 3905·7 (silicium i.). As the lines belonging to Sir Norman Lockyer's group iv. are near oxygen and nitrogen lines, and always disappeared from the spectra with the air lines, and as oxygen and nitrogen have been shown to exist in the absorbing atmospheres of the stars the spectra of which show this group (*e.g.* β Crucis), M. Gramont suggests that these lines are attributable to air (*Comptes rendus*, No. 3, vol. cxxxix.).

LINE OF SIGHT CONSTANTS FOR SOME ORION TYPE STARS.—In No. 3, vol. xix., of the *Astrophysical Journal*, Miss E. E. Dobbin gives a list of line-of-sight constants for 112 stars of the Orion type, computed for the reduction of the Bruce spectrograph observations.

Dr. Schlesinger's formulæ, as employed in his "Line-of-Sight Constants for the Principal Stars," were used, and the name, magnitude, position, and constants are given for each star. The longitude is given for 1900, and therefore requires the 50″ precession correction for each year since then.

THE TAILS OF BORRELLY'S COMET (1903) AND LIGHT-PRESSURE.—Mr. S. A. Mitchell, of Columbia University, has calculated the value of the repulsive force due to light-pressure which acted on the several tails of Borrelly's comet. Using the values for the angle between the radius vector of the comet's path and the tail, as determined by Prof. Albrecht, he found somewhat discordant values for the principal tail, which gave, in the mean, the value for the light pressure as 18·47 times gravity. For the secondary tail the values were much more consistent, and gave a mean of 1·824 times gravity; the last four lines given in this table, which were derived from measures of the angle on August 13, 14, 15, and 18, give a mean for the repulsive force of 1·460 times gravity, and therefore appear to indicate the existence of a third tail, which the photographs obtained on August 12 and 15 corroborated.

In a second table Mr. Mitchell compares the values of the angles between the tails and the radii vectores as obtained (1) by calculation from the repulsive forces given above, (2) by direct measurement. The results agree fairly well considering the uncertainty of the measures of such ill-defined objects as the tails. The differences between the observed and calculated values for the principal tail as the comet approached the sun indicate the presence of some other repulsive force in addition to that caused by light pressure, and Mr. Mitchell believes that part of this, at least, is real. The size of the particles forming each of the three tails, as determined from the above repulsive forces, was $0·1\mu$, μ, and $1·33\mu$ respectively (*Astrophysical Journal*, No. 1, vol. xx.).

SURVEY OF INDIA, 1901–2.—A volume of "Extracts from Narrative Reports of the Survey of India, 1901–2," published at Calcutta (1904), contains accounts of the work done by several parties of surveyors in connection with the triangulation of Upper Burma, latitude operations, the magnetic survey of India, tidal and levelling operations, and the topography of Upper Burma, Sind, and the Punjab.

During the latitude operations some puzzling anomalies were discovered between the observed and calculated values, the difference O–C preserving its positive character to a point much further north than might be expected.

The latitude results obtained, using stars from Newcomb's catalogue and from the Greenwich ten-year catalogue for 1880, show the same probable errors, but there is a noteworthy consistency of sign and amount (about +0·3″) in the value Newcomb-Greenwich.

An interesting account of the practical details of the magnetic survey, and of the instrumental equipments at Dehra Dun, Kodaikanal, Calcutta, and Rangoon are given in part iii., where the principles of several new and modified instruments are also fully described.

THE BRITISH MEDICAL ASSOCIATION IN OXFORD.

THE seventy-second annual meeting of the British Medical Association, which was held in Oxford last week (July 26 to 29), was beyond question one of the most successful meetings in the memory of members of the association, as it was in point of numbers much the largest yet recorded.

It was remarkable also for the persistence and enthusiasm with which, in spite of all the counter-attractions of that ancient and glorious seat of learning, and of the diversions, entertainments, and receptions arranged both by the

members of the university and by the citizens, a quite unusually large proportion of the members who were visiting Oxford steadily pursued the actual business of the meeting in the various sections.

Not only was the occasion distinguished by the presence and participation in the sectional meetings of a considerable number of eminent foreign visitors, and of an exceptionally numerous gathering of the recognised leaders of thought and investigation in medical science in our own country and the colonies, but it was also rendered memorable by the great importance and originality of the new work brought forward in many of the sections. Indeed, both in the science and the art of medicine in its widest sense, notable results of signal interest were recorded; and more than one sectional meeting witnessed the initiation of far-reaching advances, the significance of which it would be difficult to overestimate.

An academic interest was lent to the occasion by the presence of the Vice-Chancellor at a number of the meetings, and by the holding of a special convocation of the university, at which the doctorate in science, *honoris causa*, was conferred upon the following distinguished members of the association :—

Dr. T. Clifford Allbutt, F.R.S., regius professor of physic in the University of Cambridge; Mr. Andrew Clark, chairman of council, British Medical Association; Dr. T. D. Griffiths, late president of the British Medical Association; Mr. Jonathan Hutchinson, F.R.S., late president of the Royal College of Surgeons of England; Sir William Macewen, F.R.S., regius professor of surgery in the University of Glasgow; Sir Patrick Manson, F.R.S., of the London School of Tropical Medicine; Sir John W. Moore, formerly president of the Royal College of Physicians of Ireland; Prof. Osler, of Johns Hopkins University.

At the annual general meeting of the association the Vice-Chancellor of the university, Dr. Monro; the Dean of Christ Church, the Very Rev. T. B. Strong; the master of University College, Dr. Bright; and Mr. A. G. Vernon Harcourt, F.R.S., of Christ Church, were elected honorary members of the association.

The president, Dr. William Collier, took as the subject of his address "The Growth and Development of the Oxford Medical School." Starting from the period when the study of science and medicine in Oxford was at such an ebb that the school had been justly spoken of as "a lost medical school," he showed how large a part the association had played in its re-establishment.

By the action which it took in 1879 in memorialising the House of Commons, the university commissioners, and the hebdomadal council, it had afforded most material assistance to the late Sir Henry Acland and his colleagues at a critical period in the struggle which they were carrying on in Oxford. The work of Acland had been nobly carried on by his successors. Under their guidance there had gradually again grown up in Oxford a school of natural science and medicine which was already taking a prominent place among the leading schools of science in the country.

After emphasising the advantages which had thus accrued both to the profession of medicine and to the university, Dr. Collier drew a vivid picture of the brilliant past of Oxford medicine at the time when, in the sixteenth and seventeenth centuries, the university formed the centre of English scientific thought, and numbered on her roll such names as those of Willis, Boyle, Wilkins, Lower, Wren, and Harvey. To-day, he said, Oxford was again alive to the importance of science and the scientific method. Nothing save the bitter need for necessary endowments hampered her and held her back from bearing once again a noble part in the advancement of natural knowledge, and rivalling the scientific glories of her past.

Continuing, Dr. Collier said we all of us realised that the provision which has to be made for a modern scientific education is of necessity a costly undertaking. He wished more particularly to emphasise this point, because the amount of work done in the way of instruction in the scientific departments of the university for a totally inadequate remuneration was well recognised and much deplored. He would quote the words spoken recently by His Majesty the King at Cambridge :—"the older universities must receive new endowments, if education within my realms is to be kept at its proper standard of efficiency."

One could but hope that these new endowments of which the university stood in such urgent need would speedily be forthcoming; and one found a difficulty in understanding how it was that a university such as that of Oxford, with its noble traditions and its long roll of illustrious dead—a university which for many centuries had been, with the sister University of Cambridge, the acknowledged training school of the leaders of thought and action in the country—failed to appeal to those fortunate individuals who were in a position to do their country and education a service, and to enrol their names on that imperishable record of benefactors whose memories we honour and extol.

The addresses in medicine and surgery delivered by Sir William Selby Church and Sir William Macewen were of great importance, and a valuable popular lecture on disease germs, open to the public, was delivered by Dr. Bagot Ferguson.

Sir William Church dealt with the relation of medicine to the State, and with the pressing questions in public health. The national health, he urged, was a matter "of supreme importance far transcending the ordinary political issues of the day." But at the present time the administration, even of the Acts which had been secured, was ineffective.

He was afraid, from the nature of the report of the Treasury Committee appointed to consider the position and duties of the Board of Trade and the Local Government Board, that there was not much prospect of the Public Health Department of the Board receiving any increase either of power or payment. The health of the nation, on which its success and prosperity depend, was thrust into the background with the remark that the president of the board "has the advantage not only of the professional opinion of the Medical Officer of the Board, but also of the general administrative experience of the Permanent Secretary."

He thought that in pressing the necessity for the reform of the Local Government Board upon the attention of the president and the Government, three points should be especially emphasised :—first, that the central authority should act as an advisory as well as a supervising authority; secondly, that both in the Local Government Board and in the local authorities the medical element should have greater weight; and, thirdly, that the medical officers of these authorities should exercise further supervision and control over the purity and wholesomeness of articles sold for food.

In the section of anatomy Prof. D. J. Cunningham introduced a discussion upon giants and dwarfs. He regarded gigantism and acromegaly as morbid processes having many points of similarity, and stated that of the cases of gigantism on record thirteen were certainly acromegalic. Dr. Gibson and Prof. Symington also supported the view that gigantism is a pathological condition, and is associated with disease or abnormality of the pituitary body. Dr. Hastings Gilford held that giants and dwarfs may be either natural or pathological. He described three forms of dwarfism, which he illustrated by a number of living cases. He also exhibited a beautiful series of photographs bearing on ateleiosis and progeria.

In connection with this section Dr. Keith exhibited a series of hearts to demonstrate the arrangement of the auricular musculature forming the valves described by him as closing the venous orifices during normal auricular contraction. The observations which he has made have also led to the elucidation of the mechanism by which the right crus of the diaphragm, acting upon the heart, produces what is termed by physiologists "the respiratory pump." They also explain the means by which a number of the changes in the circulation taking place at birth are brought about.

Dr. Keith also had specimens proving the existence of a sphincter muscle at the ileo-cæcal valve in man.

Dr. Keibel, of Leipzig, showed an instructive series of models of the development of the urogenital system of Echidna, and Dr. Bryce detailed his observations into the origin of embryonic leucocytes, derived from a study of the histogenesis of the blood of larvæ lepidosiren.

The section of physiology held a discussion on the thalamic region in conjunction with the anatomists. The discussion was opened by Dr. Gustav Mann, who divided the central nervous system into an anterior part limited

behind by the posterior commissure, and a posterior portion which he termed collectively the cord. He described several new nuclei in the thalamus, and illustrated his conclusions by a series of models, microscopic sections, and stereoscopic photographs of the thalamus in monkeys and rabbits.

Sir Victor Horsley dwelt on the necessity for making both horizontal and sagittal sections of the thalamus, and for directing attention to cell-systems rather than to tracts of fibres. The current system of dividing the thalamus into tracts of fibres is quite untrustworthy unless checked by the degeneration method. His excitation experiments, so far as they had gone, confirmed Dr. Mann's results.

Dr. F. Griffiths and Dr. W. B. Warrington read an interesting paper on the varieties of the cells of the spinal ganglia and their relationship to axons of different distribution, and showed a useful series of illustrative microscopical sections.

Among many other valuable papers and discussions may be mentioned the important debate on chloroform anæsthesia and the demonstration given by Mr. Vernon Harcourt of his apparatus for the administration of known percentages of chloroform vapour. The apparatus is convenient and compact, and guarantees that the amount of chloroform administered is never in excess of 2 per cent. of the inspired air. An apparatus of a similar purpose by Dubois was also shown by Dr. Chapman.

In the section of pathology an unusual amount of valuable new work was published. The discussion on immunity was opened by the president, Dr. Ritchie, who began by pointing out what definite conclusions were now firmly established, and what were the problems which awaited solution. He then discussed the relation of the processes concerned in the immunity reaction to normal physiological events, and the general bearing on the question of the more important recent work. Dr. Bulloch followed, dealing in a masterly fashion with the cellular aspects of the problem of immunity, and Dr. Dreyer, of Copenhagen, read an important paper on agglutinins.

Dr. Madsen, of Copenhagen, then described the steps by which, in association with Prof. Arrhenius, he had shown that the relation of toxin and antitoxin in the living body, exemplified in what is known as "Ehrlich's phenomenon," cannot be explained, as Ehrlich holds, as being due to the presence of degenerated toxins in the crude bouillon from diphtheria or tetanus cultures. While not denying the existence of such degenerated toxins in the bouillon cultures, they maintain that the phenomenon is due to the fact that toxin possesses only a weak affinity for its corresponding antitoxin. It thus results that dissociation phenomena occur between the toxin, antitoxin, and the toxin-antitoxin molecules. In support of this view new evidence was submitted from investigations carried out upon ricin and anti-ricin, snake venom and antivenene, and saponin and its anti-body, cholesterin.

Further contributions to the study of snake venoms were communicated by Dr. C. J. Martin and Dr. Noguchi.

Dr. Wright described the experiments which led to his discovery of the bodies which he terms opsinines. These bodies have the property of enabling phagocytes to attack bacteria. They are present in the blood serum, but not in the phagocytes themselves, and they can, like anti-bodies, be transferred to foreign phagocytes, upon which they then confer a like bacteriolytic power.

At a later period of the meeting Dr. Wright gave a most lucid demonstration of the numerous brilliant modifications and new methods which he has introduced, and which have simplified and much increased the accuracy of all kinds of blood investigation and research into the mechanism of bacteriolysis.

A discussion was also held upon the *rôle* of the lymphocyte. This was opened by Dr. Lovell Gulland and Prof. Muir, and many valuable communications were contributed, notably a paper by Dr. Beattie, of Edinburgh, in which he concluded in favour of the endothelial origin of many of the mononuclear cells in inflammation. The discussion revealed the fact that a considerably greater uniformity of opinion as to the origin of the various kinds of leucocytes is coming into existence among pathologists.

The subject of the third discussion was the chemical pathology of gout. This was opened with a most able paper from Prof. von Noorden, and in the course of the discussion Dr. Walker Hall gave a demonstration of his simple apparatus for the rapid determination of the urinary purins.

In the section of tropical diseases Colonel Bruce opened the discussion on trypanosomiasis with a suggestive paper, in the course of which he stated that trypanosomal fever is in all probability the first stage of sleeping sickness, and that the *Glossina palpalis* is the medium of transmission.

A discussion was also held on the significance of the Leishman-Donovan bodies. This was introduced by Major Leishman, who pointed out the occurrence of these bodies in kala-azar, and maintained that they probably represent a stage in the life-history of a flagellate organism closely resembling a trypanosome. Dr. G. C. Low exhibited sections of the spleen from a case of kala-azar, showing these bodies *in situ*. He also exhibited a number of specimens showing the perivascular infiltration in the brain and cord in sleeping sickness.

Very instructive exhibits illustrating the conditions in ankylostomiasis and bilharzia infection were shown by Dr. Armand Ruffer and by Dr. Sandwith; and Dr. Nabarro showed specimens of trypanosoma from Uganda.

In the section of State medicine the president, Dr. J. S. Haldane, opened a discussion on standards of ventilation, discussing the effect upon the human system of poisonous gases and dust. The dust nuisances he considered could be better prevented by special measures, such as water sprays, than by a general increase of the ventilation. Subsequently he dealt with the effects of breathing air contaminated with an excess of carbonic acid gas, or containing a deficiency of oxygen or an increase of organic matter. The real pathological effects of such conditions, he held, were slight. The discussion was continued by Dr. Jones, Dr. Oliver, Dr. Hay, and others.

Dr. Newman opened a discussion on the control of the milk supply. Having reviewed the dangers to the nation which spring from the present inadequate and contaminated milk supply, he urged that the initiative for reform must come in the first place from the consumer. So far as legislation is concerned, he thought that all that could be expected was a systematic and universal enforcement of the Dairies Order. Dr. Henri de Rothschild agreed with Dr. Newman that the demand for reform must come from the consumer. The chief difficulty appeared to him to lie in the fact that the consumer wanted good milk at a price for which only bad milk could be purchased.

GEOLOGICAL NOTES.

"THE Stone Reefs of Brazil, their Geological and Geographical Relations, with a Chapter on the Coral Reefs," is the title of a memoir by Mr. J. C. Branner (*Bull. Mus. Comp. Zool. Harvard Coll.*, vol. xliv., geological series, vol. vii.). These stone reefs form striking features along the Brazilian coast from near Ceará to Porto Seguro; they are formed of sandstone, in places almost a quartzite, and stand flush with the water at high tide, while at low tide they are left exposed like long, low, flat-topped walls. The ports and towns behind these reefs owe their existence to them, as they form natural breakwaters, usually standing across the mouths of streams and estuaries.

In origin they are due to the solidification of beach sands. Coral reefs are now growing over and upon the stone reefs in some places, while at other places there are stone reefs overlying dead coral reefs.

Evidences of great depression and subsequent elevation occurred in late geologic times, and the sandstone reefs were formed when the land had finally risen. The author points out that in a region of concentrated rainfall and long droughts the river mouths had become temporarily closed, and the abundant aquatic and other life in the lagoons thus formed contributed to the organic acids of the waters. These waters, upon penetrating the dam of beach sand, first dissolved the carbonate of lime in it, and re-deposited this as cement when in contact with the dense sea-water on the ocean side. In this manner some portions of the beaches have been hardened, while others have remained incoherent.

In an able article on the modes of occurrence of intrusive rocks, Mr. J. G. Goodchild discusses the question whether they displace or replace the rocks which they invade (*Proc. Roy. Soc. Edin.*, xxv., No. 3). He cites and figures

numerous examples which support his views that in the main the process has been one of replacement, the intrusive rock eating its way into sedimentary rock which remains undisturbed above and below, and shows no sign of having increased the thickness of the strata. In certain cases where there is evidence of some displacement or mechanical rupture in the rocks affected by igneous intrusions, he finds that the extent of the displacement is, as a rule, by no means commensurate with the volume of the rock intruded. The subject was dealt with many years ago in an article on the Whin Sill by Mr. C. T. Clough, and that author, in referring to the fact that the dolerite maintained a uniform composition, although it replaced beds of diverse mineral constitution, pointed out that these difficulties disappeared when we regarded the molten rock as having a general circulation in its mass which would lead to a uniformity in its composition. Other observers, mentioned by Mr. Goodchild, have dealt with this interesting subject, but it has not before been so forcibly presented by an array of facts to which the author has himself largely contributed.

Figures of some notable crinoids are given in the quarterly issue of the *Smithsonian Miscellaneous Collections* (vol. xlv., June 15). These illustrate some notes made by Mr. Charles Schuchert, assistant curator of stratigraphic palæontology in the National Museum at Washington, who spent four months in Europe studying fossil faunas and their stratigraphic sequence in the field and in museums. He returned with "sixteen boxes of European fossils," which, as observed, will form "a good nucleus for comparative studies with the American faunas."

Prof. R. S. Tarr has directed attention to a series of artesian well borings which have been carried through the lacustrine delta deposits on which the main portion of the City of Ithaca, New York, is built. The superficial strata comprise clays 40 to 60 feet thick, beneath which are sands and gravels 20 to 70 feet, then glacial lake clays about 100 feet, and at base (resting on the bedrock) a morainic series of till, sand and gravel, 80 feet or more in thickness. The greatest thickness of drift was 342 feet. Artesian water was met with in both series of gravels—that in the upper series being derived from the alluvial fans opposite the mouths of the streams that descend to the Ithaca delta. The water found in the deeper sands and gravels is believed to be derived from the moraine which occupies the Cayuga Valley, distant more than eleven miles from the sites of the wells, and at a sufficient elevation to account for a yield under pressure at one well of 300,000 gallons of water a day.

In an article on the hanging valleys in the Finger Lake region of central New York (*Amer. Geol.*, May), Prof. R. S. Tarr gives reasons for his conviction that the glacial erosion theory cannot be accepted as proved in reference to that area. The land having attained a condition of topographic maturity, represented by the hanging valleys and by the gentle slopes of the main walls above the 800-foot contour, was subjected to rejuvenation. The effects of the elevation were to increase the amount of stream erosion along the main valleys, and although a moderate amount of glacial erosion is allowed, it is not regarded as the main factor in the production of the features.

The 1902–3 eruptions of Mont Pelée, Martinique, and the Soufrière, St. Vincent, form the subject of a report by Mr. E. O. Hovey (*Comptes rendus* ix. *Congrès geol. internat. de Vienne*, 1903). This report is based on data obtained for the American Museum of Natural History, and gives almost exclusively the result of the personal observations of the author. These have been given from time to time in NATURE, especially with reference to the great "spine" which appeared on Mont Pelée. The history of the volcanoes has in the present publication been brought down to the date of printing, February 1, 1904.

To the *Proceedings* of the Geologists' Association (vol. xviii. part vii.), Miss Ethel G. Skeat contributes an article on the Jurassic rocks of east Greenland, wherein the occurrence of Rhætic-Lias and Lower Middle and Upper Oolitic fossils is noted. The finding of such definite Upper Oolitic forms as *Astarte Saemanni* and *Aucella Pallasi* is of much interest. Mr. C. D. Sherborn has prepared a useful index to the four papers on zones of the white chalk of the English coast by Dr. A. W. Rowe and himself, and this is published in the above mentioned *Proceedings*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. J. Henderson Smith, Balliol College, has been elected first Philip Walker student for three years. The studentship was only founded during the past year, and is for the furtherance of original research in pathology.

The long vacation course of lectures which has been arranged by the Oxford School of Geography was opened on Tuesday last by Mr. H. J. Mackinder, the reader in geography, who delivered an address. During the present week lectures are to be given by Mr. Mackinder on "Leading Ideas of European Geography," by Mr. J. L. Myres on "The Physical Conditions of Greek Civilisation," and by the Rev. E. C. Spicer on "The Structure of the Oxford Region." Next week the lecturers will be Mr. C. R. Beazley, who will take as his subject "The Advance of Geography—Land Travel, Oceanic Exploration and Scientific Geography," and Prof. W. W. Watts, F.R.S., who will speak on "Charnwood Forest as a Study in the Origin of Landscapes."

MISS M. STOKES, PH.D., has been appointed to a demonstratorship in botany at the University of Manchester.

DR. G. SENTER has been appointed lecturer in chemistry at the St. Mary's Hospital Medical School, Paddington.

THE University of London will be represented at the International Congress of Medicine, to be held at Lisbon in April, 1906, by Sir Thomas Barlow, K.C.V.O., M.D., and Dr. A. D. Waller, F.R.S.

A RESEARCH studentship of 100*l.* a year for two years is offered by the London School of Economics and Political Science. The examination will be held on October 11 and 12. Full particulars may be obtained on application to the director of the school, Clare Market, London, W.C.

WE have received a copy of the *Johns Hopkins University Circular* for July, which contains the programme of the courses of study for 1904–5. Next session's work will be the twenty-ninth year of instruction at this university in Baltimore, and the provision made for every class of student is remarkably complete.

PROF. W. E. DALBY has been appointed professor of civil and mechanical engineering at the Central Technical College, South Kensington, in the place of Prof. W. C. Unwin, F.R.S., resigned. Prof. Dalby has hitherto occupied the chair of mechanical engineering and applied mathematics at the City and Guilds Technical College, Finsbury. Applications for the filling of the latter post are invited.

THE Senate of the University of London has accepted the offer made by the Goldsmiths' Company to provide an additional sum of 5000*l.* in connection with the recent gift to the university of the Goldsmiths' Institute at New Cross. This further donation of the Goldsmiths' Company will enable the university to carry on during 1904–5 at the New Cross Institute the classes of a polytechnic character which have proved very popular and useful in previous sessions. The classes to be held next winter will be arranged by the Senate in consultation with the London County Council.

THE Senate of the University of London has decided that in future internal and external candidates for the Bachelor of Science honours degree in botany, chemistry, physics, physiology and zoology must produce note-books of their laboratory work, which may include a record of any research work in which they have participated. The entries in such note-books must be duly certified by the teacher if any, and will be taken into account in estimating the qualifications of candidates, provided only that the research work be not allowed to take the place of such sound general knowledge as should be required from an honours candidate.

THE Senate of the University of London and the council of University College have now agreed on the text of the Bill for the incorporation of the college in the university. The sum required before the formal transfer can actually be effected has not yet been received in full, about 18,000*l.* being still required, but steps are to be taken to deposit the Bill with the view of its introduction next session. The Drapers' Company has announced that, being satisfied with the conditions under which the incorporation is to be effected, it is prepared to pay off the debt on the college land and buildings to the extent of 30,000*l.*, on condition

that both university and college continue to use their best endeavours to raise the balance of the sum required.

THE formation of a separate day department at the Northampton Institute, Clerkenwell, dealing with technical optics has already been referred to in these columns. We have now received full particulars as to the courses of work arranged for the coming session. The chief object of the instruction provided will be so to train the students that they will be in a position on leaving the institute to deal with the numerous problems which all who aspire to take the higher positions in the optical trades must be prepared to solve. The full course as at present contemplated extends over two years, and consists of lectures, laboratory and drawing-office work, and workshop practice. To meet the case of those who cannot devote their whole time to the training, and are already engaged in some optical trade, partial courses requiring attendance on two mornings per week only, but extending over three years, will be given, covering generally the work of the first year of the complete course, but omitting those portions with which such students will be familiar. Practical optical design will be a special feature of the advanced classes.

IN his report under part ii. of the Education Act, 1902, upon the provision and promotion of higher education in Worcestershire, Dr. Rawson, the director of education, directs attention to the fact that there is not in the county for the education of which he is responsible a single technical institution which has any day work for students over sixteen years of age. Because of the impossibility of utilising existing institutions for day technical instruction, which should be their chief use, they are to be turned to account as secondary schools. After explaining that to rejoice because a technical institute is available for a secondary school is really to be glad that an expensive building cannot do the work for which it was built and equipped, Dr. Rawson goes on to show that there is another contributing cause to the lack of technical and higher education. It cannot be denied, he says, that employers of labour are within their rights in taking their "hands" at the age which suits the employer best; clearly, however, the retention of the young workman by the employer all day prevents most completely any day work at the technical school from being possible for such employee. It would be an unmixed blessing for the country, and an unqualified boon to master and man, if day technical instruction could be vouchsafed to the best of the young workmen in the employ of each firm. Many employers in England are now carrying out in their own works these innovations. Reports like this one of Dr. Rawson, giving as they do a bird's-eye view of the existing provisions for education of every grade in each part of the country, are most valuable, and will serve to make clear what deficiencies must at once be made good.

THE regulations for evening schools, technical institutions, and schools of art and art classes have now been published by the Board of Education. The regulations make provision for the promotion of higher technical education of suitable organisation and equipment. We are glad to notice that the board recognises the great advantage accruing from the concentration of interest which is possible only when the student can make study his single aim and devote his whole time to education. The board regards it as of special importance that, by the development of day teaching in technical institutions, there should be no lack of facilities for the instruction of those who, by private means or with the assistance of bursaries given by local education authorities, are able either to prolong their studies beyond the usual school age, or to return to study after a period of apprenticeship or of wage-earning experience. The value of evening classes at the present stage of development of English education is, however, not lost sight of, and regulations are laid down intended to ensure that local education authorities shall make the instruction in such classes suitable for the special needs of a given neighbourhood. The necessity of correlating the component parts of a student's instruction with a view to increase their educational value and practical utility is insisted upon, and it is prescribed that no student may be admitted to any course who is not sufficiently prepared to benefit by the instruction given in that course. The new regulations represent in their main features an amalgamation and simplification of the diverse regulations under which the schools and classes concerned have been administered in the past.

AT the annual distribution of scholarships and prizes at the Royal Indian Engineering College, Coopers Hill, on July 27, Sir William White, president of the Institution of Civil Engineers, delivered an address. Referring to the recent decision to close the college, he said they had now to accept the decision and to express the hope that the good work of Coopers Hill would continue to bear fruit. It is to be hoped that the features of the college, which have been proved to be good, will be in some way or other perpetuated, and that the connection of British engineering institutions with India and its great public works will in the future be quite as close as in the past. He believed that the energy and skill of engineers in the Indian Empire had been one of the greatest forces for consolidating the advance of British dominion, for improving the condition of the people, and for developing the resources of that great continent. After contrasting the condition of India at the present time with its state at the time of the Mutiny, Sir William said that the radical change which has taken place was largely owing to the triumphs of the engineer. We are only yet on the fringe of discovery in the matter of the resources of India. Its mines, its forests, and its other resources are waiting for the work of the engineer for proper development. On those in authority in this country who have the conduct of Indian affairs must depend how that development shall progress, and what shall be the future of the Indian Empire as affected by engineering and British financial enterprise. There must be huge demands for skilled engineers in India, and now that Coopers Hill will cease to be the chief source of supply of engineers for India, we must be sure that some other source of as fully trained and competent men will be provided to ensure that the resources of India do not want for development.

CONTENTS.

THURSDAY, AUGUST 11, 1904.

NATURAL HISTORY OF THE MALDIVES AND LACCADIVES.

The Fauna and Geography of the Maldive and Laccadive Archipelagoes. Edited by J. S. Gardiner. Vol. i., parts ii. to iv.; vol. ii., parts i. to iii. (Cambridge: C. J. Clay and Sons, 1902–4.)

As the general scope and character of this important work were referred to at some length in a notice of the first part which appeared in NATURE for April 3, 1902 (vol. lxv. p. 514), it will suffice on the present occasion to confine attention to some of the more generally interesting of the numerous memoirs contained in the parts now before us. By generally interesting, we mean reports which deal more especially with questions connected with morphology, development, the limitations of species, reef-formation, &c., rather than those devoted to systematic zoology, and it is on these grounds that we pass over papers like those by Messrs. Borradaile and Lanchester on crustaceans, and the one by Mr. E. Smith on molluscs (important as they are from their special point of view) in favour of some of those of the former type.

Especial interest concentrates, of course, on the chapters (vol. i., parts ii. and iv.) devoted by the editor to the origin and mode of formation of the two archipelagoes under survey. In the chapters included in part ii., Mr. Gardiner, when stating his general views on this part of the subject, definitely and unhesitatingly rejects the theory that the two archipelagoes can have been formed by the subsidence of a large central island, the topography of the central deep plateau being, in his opinion, unfavourable to such a view. On the contrary, he maintains the former existence of continuous land over the area, which was planed down by the action of currents to an almost flat plateau at a depth of about 160 fathoms, and that on this plateau the different banks originated independently by the slow growth of deep-sea corals, assisted in some small degree by nullipores, &c., but completed by the subsequent growth of a superficial reef formed by true corals and nullipores, aided by a general outward extension of the growing reef by current-borne detritus. When the superficial reef approached the surface, it is considered probable that some land was formed by elevation, or by a change in the level of the ocean. Finally, in the individual atolls the lagoon was formed partially by the more rapid growth of the organisms on the edge of the bank, thereby building up an encircling reef, and partially by the subsequent erosion of the central area. The author adduces evidence to show that certain kinds of coral will grow freely at depths of considerably more than 200 fathoms, and he adds that his views with regard to reef and atoll formation hold good for the islands of the Pacific as well as for those of the Laccadive and Maldive Archipelagoes. In the chapter in part iv. details are given of the various atolls, with remarks on apparent recent changes in the archipelagoes and on the death of corals.

Passing on to the purely zoological reports, we may notice that in dealing with the Chætognatha (Sagitta and its allies), Mr. Doncaster comments on the unstable character of the species in this group, several of which seem to graduate into others. Most remarkable is the fact that such species do not appear to be separated either geographically or in habit, closely allied forms living in the same locality under similar conditions. Consequently, it is difficult to believe that they can have been differentiated by natural selection. In his notice of the echinoderms, Prof. F. J. Bell corroborates previous observations as to the loss of the upper surface of the disc in many feather-stars (ophiurids), and further points out that if gonads are set free by the loss of this disc, and a new disc and new gonads are subsequently formed, the question of germ-plasm may be regarded as answered.

Another group which has yielded results of special interest is that of the alcyonarian polyps, the collection made by Mr. Gardiner's expedition serving to show, according to Prof. Hickson, the untrustworthy character of species formed on the evidence of single specimens. The large series of examples now for the first time available demonstrates the variation in form, colour, and other features of what appears to be one and the same specific type when collected over a large area. If, for instance, a specimen of organ-pipe coral (Tubipora) were collected in Celebes and a second in the Maldives, there is little doubt that they would be regarded as representing two distinct species, but a walk at low tide along a Maldive reef would reveal the existence of a number of intermediate types connecting the two supposed species by imperceptible gradations. These organisms, in fact, exhibit a number of "facies," which have not local limitations.

"If each facies," observes Prof. Hickson, "represents a species, then we have the remarkable phenomenon of a number of closely related species distributed over a wide area and competing in the struggle for existence, with approximately equal success, in many localities of this area. If, on the other hand, all the facies represent but one species, then we have a species capable of extraordinary variation in circumstances apparently identical."

Without recourse to cross-breeding, it is impossible to demonstrate which of the two propositions is true, and the only practical course is therefore to regard as species all the unconnected types.

The species question is resumed in the chapters on madreporiform corals (vol. ii. part iii.), where Mr. Gardiner remarks that he has found much less difficulty in finding the limitations of species among the Astreidæ than was experienced by Mr. Bernard in the case of the perforate group. The puzzle will, he thinks, in both cases be solved by definitely ascertaining which variations are discontinuous and which continuous. Here occasion is taken to notice the favourable conditions presented by corals for the study of variation, owing to the fact that the larvæ have no choice in their environment. Unless there be real action on the part of the local environment in producing discontinuous variation in the gametes of new immigrants, it will be obvious that the species must remain approximately constant.

Another report demanding special notice is the one by Mr. R. C. Punnett on the Enteropneusta, the collection brought together by Mr. Gardiner being the most extensive hitherto made in any one locality. This richness has enabled Mr. Punnett to attempt the study of the variation (that is to say, the development of local forms) displayed by certain members of the group, this having never been previously practicable. In addition to the description of new species of Ptychodera and Balanoglossus, the author takes the opportunity of describing a new generic type from Zanzibar, for which the name *Willeyia bisulcata* is proposed, characterised by its large size and the great length of the proboscis and collar. After discussing many debatable structural features connected with these curious organisms, Mr. Punnett takes occasion to express his opinion of the importance of Willey's theory as to the origin of gill-clefts, which he believes to obtain further support from the evidence of this group. To recapitulate the author's views in detail would occupy too much space, and it can only be mentioned that the gonads are suggested as being the prime factors in the segmentation of the Chordata, each gonad having ultimately acquired an independent aperture of escape from the body, which became subsequently used for respiration, and thus a gill-cleft.

If we pass over the accounts of the Chordata by Messrs. Cooper and Punnett, it is only from lack of that space necessary to do anything like justice to one of the most important biological and physiographical works of our time. To conclude without expressing our opinion as to the business-like manner and thoroughness with which both the expedition itself and the examination and description of the specimens and the codifying of the general results have been carried out (so far as they are yet published) would, however, be alike ungracious and unappreciative.

R. L.

JOHN PARKINSON'S "PARADISUS."

Paradisi in Sole Paradisus terrestris. By John Parkinson. Faithfully reprinted from the edition of 1629. Pp. l+612. (London: Methuen and Co., 1904.) Price *2l. 2s.* net.

THIS is a handsome reprint of a notable book, which, even in its original form, never made so brave a show as does this facsimile, with its fine type, excellent paper, rough edges, and grey paper boards. The page illustrations suffer somewhat in sharpness, owing to the process by which they have been reproduced, in comparison with the cuts in the older editions, which were worked from the blocks themselves. It is a genuine reprint; with the exception of a half-title and the title-page set out above, the old herbalist's book is left to tell its own tale. We are glad to be spared the modern editor's introduction, which in this instance would have been an infliction.

John Parkinson, King's Herbalist, was born in 1567, and with John Gerard occupies a special position in our literature as one of our herbalists. Gerard's "Herball" was based upon Continental work, and very few cuts were due to him; Parkinson's books were his own, woodcuts and text alike. Gerard's "Herball" was edited and much improved by Thomas Johnson in 1633, and was reprinted in 1636; Parkinson's "Paradisus," which came out in 1629, when the author had passed his sixtieth birthday, was reprinted in 1656, six years after his death, practically unaltered. He regarded the "Paradisus" as constituting three parts of a comprehensive treatise on plants—the garden of pleasant flowers, the kitchen garden, and the orchard. Eleven years later, the fourth part, his "Theatrum," appeared, devoted chiefly to medical plants, but in bulk much exceeding his previous publication.

We have before us copies of all the issues; the original issue of 1629, with its thin, foxed paper and striking woodcuts, and its reprints. Parenthetically it may be remarked that these blocks, measuring ten inches by six, do not appear to be built up, as boxwood blocks, but were cut along the grain, and consisted of pear-wood. The actual blocks are not extant, but judging from woodcuts of the same century we are justified in assuming that Parkinson's illustrations were produced as we have said. The old authors were economical of their blocks; Dodoens, Clusius, and their contemporaries were apt to square off their plants to fit the block, or to twist the plant to come within the limits available. Here we find many specimens displayed on the same block, sometimes ingeniously arranged in a give-and-take manner. No book gives a better idea of the gardens of the time, with their plans and plants, than the volume before us; the author starts with general principles of laying out or "ordering" his garden, and then goes on to describe what should grow in it—hardy flowers nearly all, but the variety of tulips, iris, narcissus, and similar plants strikes a modern reader. Many little touches of human personality shine through the accounts given; old colleagues and benefactors by whom certain bulbs or seeds were introduced are mentioned; some of those named may be found in the works of other authors, and we greet them as old friends; some of them appear in connection with their favourite flowers, as "John Tradescant his great Rose Daffodill," or "Mr. Wilmer's great double Daffodill." It is largely due to the revived love for hardy garden flowers, especially the narcissus, that Parkinson's book has of recent years become almost impossible to get, the price having risen from shillings to nearly as many pounds within one generation.

The second issue varied from the first by having a printed title-page in front of the engraved one, and although it boasted of being "much Corrected and Enlarged," many of the printer's errors noted in the first were not corrected in the second edition; the pages are not precisely the same, nor are the tables at the end, and the only noticeable enlargement is the letterpress title-page just mentioned.

The third issue is that now under review, but the publishers seem to have failed to notice the pun in the title, which at length runs thus:—

"Paradisi in Sole Paradisus Terrestris. Or a Garden of all sorts of pleasant flowers which our English ayre will permitt to be noursed upp: with A

Kitchen garden of all manner of herbes, rootes, and fruites, for meate or sause used with us, and An Orchard of all sorte of fruit-bearing Trees and shrubbes fit for our Land together With the right orderinge, planting and preserving of them and their uses and virtues. Collected by John Parkinson, Apothecary of London, 1629." It will be observed that the first five words mean "of Park-in-Sun the Earthly Paradise," and this play upon his own name is missed in the special title of the reprint.

It is impossible even to indicate the charm of this old book; a long notice would still be inadequate, while to those who love old garden flowers and these quaint notices of them, this reprint will afford a new delight.

B. D. J.

MODERN ELECTRIC PRACTICE.

Modern Electric Practice. Edited by Magnus Maclean. In six volumes. Vol. i., pp. viii+270. Vol. ii., pp. vi+297. Vol. iii., pp. vi+285. (London: The Gresham Publishing Co., 1904.) Price 9*s*. net per volume.

THESE volumes have been published with the intention of providing a comprehensive treatise on the subject of modern electrical engineering, a subject now so large and so diversified that it is beyond the power of one man, however expert, to deal with it in all its aspects. The plan has therefore been adopted of inviting the collaboration of a number of authors, each writing of that section with which he is particularly conversant, and thus producing a sort of encyclopædia of electrical engineering which might be compared with such books as Watts's "Dictionary of Chemistry." It is difficult to form an estimate of the value of a book of this kind, which depends as much upon the skill and discretion which are shown in the selection and arrangement of the material as upon the merits possessed by the individual contributions.

Regarded as a whole we consider this compilation disappointing in the extreme. A really standard work of reference on electrical engineering would be a very welcome addition to electrical literature, a book to which a man could turn for information about any matter which happened to crop up in the course of his work, certain of finding a thorough *résumé* of the subject sufficient to give him the outlines of existing knowledge and to put him on the track of more detailed information if he required it. The volumes before us unfortunately cannot claim any such position; indeed, as a work of general reference they are almost useless. A series of text-books by different writers on different subjects does not make a comprehensive treatise because these text-books are bound between the same covers and "not sold separately." No serious effort seems to have been made to coordinate the material properly, and, in fact, almost the only attempt at uniformity which can be discovered is in the direction of print and paper. A single quotation from the preface is enough in itself to support this contention; the editor there says, "rises of temperature are given sometimes in degrees Fahrenheit and sometimes in degrees Centigrade; dimensions of machines occasionally in feet and inches but more often in centimetres; magnetic flux density in lines per square inch in one article, and in lines per square centimetre in another." We can see no way in which to regard this paragraph other than as a confession of careless editing, as we should have thought the very first thing the editor would do would be to adopt a uniform system of units and notation throughout. Other instances of more serious carelessness might be quoted, but we will content ourselves by giving one example. In the three volumes already published we have come across two tables giving the relative conductivities and temperature coefficients of various substances; in one the values of the resistivities are given, in the other the relative conductivities. A very cursory examination shows that the two tables do not agree, and if they are compared more carefully we get results of which the following are specimens (the conductivity of iron being taken as the standard for comparing the two tables):—

Relative conductivity of	iron	Table I.	16·2	Table II. 16·2
,, ,,	copper	,,	97·5	,, 90 & 92
,, ,,	mercury	,,	1·65	,, 1·56
,, ,,	platinum	,,	19·0	,, 13·4
,, ,,	aluminium	,,	52	,, 55

The agreement between the temperature coefficients is equally bad. We have purposely only compared above the figures for elementary substances, as those for alloys such as German silver, manganin, &c., which are in even worse disagreement, are valueless in one table as the percentage composition is not given. Comment on figures of this sort is needless.

Enough has probably been said to show that as a standard treatise on electrical engineering the value of these volumes is little or nothing. This is the more to be regretted as they have been produced in a style which may be described as lavish, and several of the contributors are in the front ranks of the profession, able to write with an authority on their particular subjects which cannot be called in question. It would not have required very much more trouble and care to have converted the publication into a first-class addition to the electrical engineer's library instead of leaving it as a book only to be valued on account of the occasional articles of exceptional merit which it contains. Space would not permit us to review these in detail here even were it profitable to do so. Suffice it to say that there are several contributions which thoroughly deserve to be read, some because of the admirable way in which they treat their subject-matter, and others because, in addition, they are practically the only existing English text-books on the subject. On the whole, however, we think the level is not very high, especially if scientific treatment be looked for; there is a general tendency for too much description, too much of an account of what the practical engineer has made, and too little of the theoretical principles on which his practice is based. It is evident, of course, that the book does not aim at discussing the theoretical side of electricity and magnetism, but even "modern practice" must be studied, if it is to be properly studied, with a certain

amount of theory as a basis, and a book which does not supply, in each branch, the necessary minimum hardly deserves to claim the title of a "comprehensive treatise." MAURICE SOLOMON.

PIONEER IRRIGATION.

Pioneer Irrigation for Farmers in the Colonies. By E. O. Mawson, M.Inst.C.E. With Chapters on Light Railways, by E. R. Calthrop, M.Inst.C.E. Pp. xvi+260. (London: Crosby Lockwood and Son, 1904.)

THE preface states that "this book has been written with the object of supplying pioneer farmers, in arid countries, with information which may assist them in conserving the precarious rainfall, and utilising it for the irrigation of crops"; also that "only the most homely contrivances, such as can be constructed and worked without professional advice or skilled labour are suggested"; and that the object "throughout the volume has been to demonstrate, in the simplest possible manner, how the available water-supply—whether surface-flow or underground—can be used for irrigating crops by means of works easily constructed at a small expenditure, without fear of danger in case of failure." The book, however, is not in reality confined within these prescribed limits; for it refers to earthen dams, with puddle trench, waste weir, and outlet valve tower, masonry dams of moderate height for forming reservoirs in gorges, a masonry aqueduct of several spans, and a barrage or weir across an apparently wide river, closed along the upper portion by a series of automatic sluice-gates. The works, indeed, shown in some of the woodcuts, and especially on plates 3 to 8, 10, and 19, could not possibly be regarded as homely contrivances, capable of being easily carried out by pioneer farmers, without skilled labour, at a small cost, and without danger to the neighbourhood in the event of failure.

The chapters on the value of irrigation and sources of water-supply, underground waters, methods of irrigation, and the cultivation of irrigated crops, vegetables, and fruit trees, contain much information which would be very useful to persons engaged in the cultivation of arid districts; but most of the works described in the chapters on dams and weirs, canals, sewage irrigation, and automatic sluice-gates, would be wholly beyond the resources of pioneer farmers. The storage of rainfall, the collection of the run-off of water in the rainy season by open tanks formed in depressions enclosed by low banks, and the drawing of underground waters from wells, are works which can be readily undertaken with great benefit by cultivators of arid lands; but the formation of large reservoirs by damming up valleys, and the raising of the water level of rivers and the conveyance of the water considerable distances in irrigation canals, constitute works which have to be carried out by a company, the local authorities, or the Government, for the irrigation of large tracts of land. Sewage irrigation, moreover, can only be made use of in the neighbourhood of large communities, and is not available amongst the sparse population of a newly-settled agricultural district.

In a chapter on automatic sluice-gates, a system of hinged gates or shutters is advocated for raising the water level of reservoirs and rivers, which has apparently been patented by one of the authors; but it is not stated that the design has been put into operation; and such automatic contrivances, as in the case of the movable shutter weirs employed long ago for the canalisation of some rivers in France, are liable to be very irregular in their action. The two concluding chapters furnish some interesting particulars about light railways, which are introduced with the view that the conveyance of the produce of irrigated lands to a market is second only in importance to the supply of water. Such works, however, with the great advantages that they afford, have to be carried out in the midst of a thriving community, where both capital and revenue are available; and they are beyond the scope of pioneer farmers who are extending cultivation into new, unoccupied districts. A long appendix is given at the end of the volume, containing various memoranda, tables, and particulars about materials and tools, which may be of service in irrigation works and farming. The book is, in fact, a short manual on irrigation works in general, with some account of the construction, suitable gauges, and rolling-stock of light railways.

OUR BOOK SHELF.

Lehrbuch der Stereochemie. By A. Werner. Pp. xvi+474. (Jena: Gustav Fischer, 1904.) Price 10 marks.

THIS book had its origin in the courses of lectures on stereochemistry delivered during recent years by Prof. Werner in the University of Zurich. The systematic form of the lectures has been adhered to, but by the addition of numerous tables and many hundreds of references to original sources, the author has produced a comprehensive handbook which must prove of great utility, not only to the general chemist who wishes to know something of the advances made in stereochemistry since the conception was first put forward, but also to the specialist whose work is directly concerned with the subject. Notwithstanding the wealth of detail, the book is of moderate compass, and whilst compression in the theoretical portions is occasionally carried to such an extent as to interfere somewhat with intelligibility, yet the book is on the whole both readable and easily comprehensible. The eminence of the author as an investigator in some of the most obscure fields of stereochemical research is sufficient guarantee of his mastery of both theory and material.

The work is composed of two chief parts, of which the first deals with stereoisomerism, divided into subsections according to the elements involved. The first subsection is naturally devoted to the stereoisomeric carbon compounds, and occupies about half of the whole book. In it are treated, amongst other matters, the theory of the asymmetric carbon atom, mirror-image isomerism, racemism and the resolution of racemic compounds, determination of configuration in open chains (more particularly in the sugars and related substances) and in closed chains, the quantitative relations between rotation and the nature of the asymmetric carbon atom, *cis-trans* isomerism in cyclic compounds, and the geometric isomerism of ethylenic compounds. The

succeeding subsection deals with the stereoisomeric carbon-nitrogen compounds, such as the oximes, and is followed by a subsection on the substances that owe their stereoisomerism to the configuration of nitrogen atoms. The first part closes with an account of the optically active sulphur, selenium, and tin compounds, and of the geometric isomerism exhibited by the cobalt and platinum compounds with ammonia and the organic bases.

The second part of the work is concerned with stereochemistry unaccompanied by stereoisomerism, under which head are treated such matters as the stability of carbocyclic and heterocyclic chains, the stereochemical formulæ of benzene, and the influence of space-arrangement on the speed or possibility of chemical reactions, *e.g.* esterisation, formation of amides from esters, formation of triphenylmethane dyes, reduction of nitro-groups. Perhaps this part of the book will be found as useful as any, for it marshals under one point of view a great array of facts otherwise scattered and difficult of access.

Prof. Werner's book should be in the possession of every organic chemist.

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Edited by W. T. Blanford. Rhynchota, vol. ii., part ii. Heteroptera. By W. L. Distant. Pp. i–iv, xi–xvii, 343–503; figs. 168–319. (London: Taylor and Francis, 1904.) Price 10*s.*

THE first part of vol. ii. of this work was published in December, 1903, and was noticed in NATURE for February 25, 1904, and we have not had long to wait for the second part, completing the volume, the preface of which bears date April, 1904. The total number of species described in the second part is 511, bringing up the total number of species described in the first two volumes of the work to 1471. The second part of vol. ii. completes the great family Reduviidæ (subfamilies Acanthaspidinæ to Nabidinæ), which is fam. 12 of Mr. Distant's arrangement. The volume also includes the families Saldidæ, Ceratocombidæ, Cimicidæ, and Capsidæ. This completes the land bugs, with the exception of the Anthocoridæ. These, with the two last families of the Gymnocerata (Hebridæ and Hydrometridæ), which are aquatic or subaquatic, are left over to be included with the Cryptocerata, all of which are aquatic, in the third volume, which will complete the work so far as the Heteroptera are concerned. The Homoptera will also be commenced in vol. iii.

Other volumes of this series in preparation are to include certain families of Coleoptera (especially those of economic importance), the butterflies, and the land mollusca.

Analytical Chemistry. Vol. ii., *Quantitative Analysis.* By F. P. Treadwell, Ph.D. Translated from the second German edition by William T. Hall, S.B. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 17*s.* net.

IT is a little curious that this volume, which appeared in German in 1901, should have reached a second edition before finding an American translator, as one might suppose that its many excellences would have hastened the fate which has overtaken a number of less valuable German treatises.

The author states in the preface that the majority of the methods which he describes have been submitted to careful examination in his own laboratory, a fact clearly evident from the minutiæ which are introduced at every step. This is precisely what gives a work on analytical chemistry a real value. There is an introductory chapter on general manipulation, details, and apparatus, including the use of the Gooch crucible, that ingenious and time-saving combination of filter and crucible which is much too little known and used.

The subsequent chapters deal with gravimetric and volumetric estimations of inorganic materials, including such methods as are specially applicable to certain minerals, ores, and metals, and there is a final chapter on gas analysis.

It should be added that the book is one for reference and is not a graduated course of instruction for students. It is, in fact, an abbreviated Fresenius without the undesirable quality of superficial comprehensiveness which characterises that exasperating classic.

J. B. C.

Arnold's Home and Abroad Readers. Book i. Glimpses of the Homeland. Pp. 135. Book ii. Glimpses of the Globe. Pp. 152. Book iii. England and Wales. Pp. 200. Book iv. The British Dominions. Pp. 232. Book v. The World's Great Powers—Present and Past. Pp. 228. Book vi. The World's Trade and Traders. Pp. 228. (London: Edward Arnold, n.d.) Prices from 10*d.* to 1*s.* 6*d.*

THE aim of the anonymous author of these volumes appears to have been first of all to secure the interested attention of his young readers, and then incidentally to teach them a great deal about the physical features of the countries of the world and of the manners and customs of the peoples of the globe. The readers are skilfully graded, well illustrated with maps and pictures, and excellently printed. The books are likely to be popular in elementary schools.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Chemical Action Produced by Radium.

VARIOUS chemical investigations relating to the chemical action of radium bromide have been in progress in this laboratory during the past session, an account of which will shortly be published.

But one of these investigations has yielded results so extraordinary that we think it well to direct attention to the results. On the Rutherford-Soddy hypothesis of the disintegration of the radium atom, an enormous amount of energy is evolved, and at least one simpler product is formed, namely, helium, which is slowly produced during the disintegration of the emanation, which Mr. Soddy and one of the authors have shown to be a gas, following Boyle's law; and with Dr. Collie the spectrum has been investigated.

It has, of course, often suggested itself that such a change should be reversible; that is, that by imparting a sufficient charge of energy to any atom, it should be transformed into different matter, probably by the building up of a more complex structure. Now the only known source of energy in such a concentrated form is that which is given off by radium and its products during their disintegration. The facts which we have to chronicle appear to point towards such a synthesis.

During experiments on the emanation, about 105 milligrams of radium bromide, dissolved in water, were kept in small glass bulbs, connected to a pump. To protect the bulbs against accident, each was surrounded with a small beaker, one of potash-glass and two of soda-glass. The former was coloured brown in the course of some six months, the latter violet. On altering the apparatus these beakers were discarded.

They were all found to be radio-active on both surfaces,

and, what is most remarkable, *the radio-activity was removed by washing with water*. The solution contains an emanation, for on bubbling air through it, and cooling the gas with liquid air, the issuing gaseous air is only feebly active; the main part of the activity was retained in the cooled bulb. This substance can be carried into an electroscope by a current of air, and when the current passes, the electroscope is discharged; but the period of decay of the emanation is very short, and in that respect resembles the emanation from actinium.

The research is not sufficiently advanced to permit of a complete account of the other products, but it may be mentioned that from the solution which has lost all emanating power further active products are obtainable, some of which are precipitable along with mercurous chloride, some along with mercuric sulphide, some with ferric oxide, and some with barium sulphate. The behaviour is different, according as potash- or soda-glass is used. That this is not a case of a body being thrown down by *any* precipitant has been abundantly proved; for example, precipitation along with mercurous chloride or sulphide failed to remove the activity from one sample, while the precipitation of ferric hydroxide in the solution completely threw down the radio-active material. There appear to be several radio-active bodies present which can be separated by the ordinary processes of qualitative analysis.

These substances, it must be remembered, are the products of β and γ rays in conjunction with the material on which they impinge. A silver crucible, too, becomes radio-active on the exposed surface only when placed in the path of β rays. It is important to note that these changes are not due to the material having been in contact with radium or any of its products; they are solely due to the β and possibly to the γ rays. The order of the activity is the same as that of 1 milligram of old uranium oxide, U_3O_8.

WILLIAM RAMSAY.
W. TERNENT COOKE.

University College, London, July 30.

Atomic Structure in the Light of Secondary Spectra.

IN making some determinations of the capacity necessary just to produce secondary spectra, I have found that this critical capacity increases very rapidly with decreasing wave-length. The primary spectrum does not go over suddenly as the critical capacity is reached, but the red and yellow portions go over first, then finally, at a much greater capacity, the violet. Critical capacity as a function of wave-length is well represented by the exponential $\epsilon^{\frac{6}{\lambda-\lambda}}$, approaching a constant value in the infra-red and the value infinity in the ultra-violet, perhaps not farther out than $250\mu\mu$.

Consider the radiation from a nitrogen atom. When subjected to feeble electrical excitation its (primary) spectrum is banded, each band being composed of numerous lines not showing the Zeeman effect. But when subjected to excessive excitation, as it is when a large condenser is connected in shunt with the conducting gas, its (secondary) spectrum consists of numerous heavy lines, showing the Zeeman effect, and expressible in Kayser-Runge series.

Runge, having in mind the Zeeman effect, supposes that primary spectra are due to positive ions while negative electrons give secondary spectra, but it is hardly conceivable that feeble excitation should all go to the positive ions while more intense excitation all goes to the negative.

I would suggest that an atom composed of rotating rings of electrons according to recent theories might easily exhibit just such radiating properties as would give primary and secondary spectra, together with the variation of critical capacity with wave-length. Suppose that there are as many rings as there are bands in the primary spectrum. With moderate excitation these rings would vibrate radially and tangentially as well as perpendicularly to their planes, and these vibrations would give rise to the lines comprising each band. Such lines would not show the Zeeman effect. Excessive excitation would break up the rings and allow the electrons to move independently. Radiation from such free electrons would constitute the secondary spectrum, and would show the full Zeeman effect. The larger rings would be the first to break up; the smallest rings, perhaps, could not be broken up at all, hence critical capacity would vary with the wave-length and become infinite for moderately short waves. Metallic atoms have ring systems that are so easily broken up that it is impossible to obtain any primary spectrum from them at all.

Washington, D.C. P. G. NUTTING.

The Flowering of the Bamboo.

CAN your botanical readers give me any information about the flowering of the bamboo? Until recently I was not aware that it presented any extraordinary features, but about the middle of April the bamboo in this locality produced flowers, to the great astonishment of everyone long resident here. The peasants, and many of the more ignorant townspeople, regarded the event with much superstitious terror. It is supposed by them to portend a failure of the crops, and possibly even more serious disasters. A small anti-tax rising, some distance away, appeared for a few days to be a serious matter, and as it was in progress during the time at which the bamboo flowers appeared, many were inclined to exaggerate enormously the danger of the situation. These superstitious terrors (closely resembling the fears formerly aroused in Europe on the appearance of a large comet) sufficiently show the rarity of the phenomenon.

On making inquiry, I could only hear of one man (I did not myself meet him) who had ever seen the bamboo in flower before.

I am told that a species of bamboo in southern California flowers annually, the flower being at the top of the plant only. In the species growing here the flowers were at all heights, arranged at frequent intervals along almost every branch of the plants. I obtained a photograph of a spray in flower, but unfortunately it is so small that the distinction between leaves and inflorescences is very imperfect.

A. TINGLE.

Imperial Provincial College, Chinanfu, Shantung, China, May.

As regards the point raised by your correspondent, I may say that the feeling of alarm aroused in the natives by the flowering of the bamboo seems to be widely spread in the East. I have myself heard of it when in India.

The fact is that the bamboo only flowers once and then dies, and as a rule the whole lot of plants, often covering large areas, bloom together.

The reason of this is that the individuals of a species are commonly gregarious, and are all of the same age, having taken simultaneous possession of ground rendered vacant, perhaps, by a previous and similar depopulation.

A somewhat analogous case is presented by some of the Strobilanths of tropical Asia. These plants live for about seven years, then all burst out into a glorious mass of blue flower, and then die away, leaving, it may be, hundreds of acres of ground destitute of the luxuriant vegetation it previously supported.

Dr. O. Stapf, in a most interesting article that appeared in the *Gardener's Chronicle* this year (Nos. 907–910), gives an account of the introduction into Europe of two bamboos that have suffered a similar fate.

In 1847 seeds of *Arundinaria Falconeri* (and another species) were received at Kew, and were thence distributed to various gardens, some finding their way to the Continent. The plants flowered (and then died) in France in 1875, and in the following year all the English plants, growing in different localities, shared the same fate.

J. B. FARMER.

Claremont House, Wimbledon Common, August 2.

The Organisation of Zoologists.

MAY I be allowed to direct the attention of the readers of NATURE to the fact that a meeting of zoologists will be held in the comparative anatomy lecture room at Cambridge on Wednesday, August 17, at 4 p.m., to consider a scheme for organisation suggested by the committee that was appointed in London on January 4. The suggested scheme has been printed and widely circulated, but as it may have failed to reach some of the zoologists of the country, I have been requested to state that all who are interested in zoology and anxious to promote its progress will be welcome.

SYDNEY J. HICKSON.

The Victoria University, Manchester, August 3.

THE BRITISH SCIENCE GUILD.

An organisation is being formed, under the name of the British Science Guild, with the object of insisting upon the importance of applying scientific methods to every branch of the affairs of the nation. A memorandum which describes briefly the objects, methods, and proposed organisation of the Guild is now being circulated, and is as follows:—

It has been a frequent subject of comment that, although the contribution of this country to the progress of science has been second to that of no other nation, the English people do not manifest that interest in, and belief in the powers of science which is noticeable among the peoples of the Continent, or of America. In spite of the efforts of many years, the scientific spirit, essential to all true progress, is still too rare, and, indeed, is often sadly lacking in some of those who are responsible for the proper conduct of many of the nation's activities. It is with the view of attempting to remedy this evil, and to bring home to all classes the necessity of applying scientific treatment to affairs of all kinds, that the proposal is made to bring together those convinced of this necessity by founding "The British Science Guild."

The objects and organisation of the Guild, which will be entirely disconnected from party politics, are as follows:—

Objects.

(1) To bring together as members of the Guild all those throughout the Empire interested in science and scientific method, in order, by joint action, to convince the people, by means of publications and meetings, of the necessity of applying the methods of science to all branches of human endeavour, and thus to further the progress and increase the welfare of the Empire.

(2) To bring before the Government the scientific aspects of all matters affecting the national welfare.

(3) To promote and extend the application of scientific principles to industrial and general purposes.

(4) To promote scientific education by encouraging the support of universities and other institutions where the bounds of science are extended, or where new applications of science are devised.

Methods of Attaining these Objects.

(*a*) By publications.
(*b*) By meetings.
(*c*) By conferences and lectures.
(*d*) By deputations.

Organisation.

Admission of Members.

All British subjects, both men and women, are eligible for membership of the Guild; it is expected, however, that its members will be recruited principally from the following:—

The House of Lords.
The House of Commons.
Colonial Legislatures.
County, District, Borough, and Parish Councils; Municipalities; Educational Committees.
Scientific and Literary Societies and Organisations.
Commercial and Industrial Chambers and Organisations.
The Learned Professions.
Universities, Colleges, Educational Bodies and Graduates of all British Universities.
Representatives of Labour.

At a meeting of the promoters of the Guild, held, by permission of the officers, at the rooms of the Royal Society on April 20, it was decided that the steps preliminary to the formation of the Guild should be taken by an organising committee, of which the following were appointed members, with power to add to their number:

Lord Avebury, F.R.S.
Prof. W. E. Ayrton, F.R.S.
Sir George Sydenham Clarke, K.C.M.G., F.R.S.
Captain E. W. Creak, R.N., C.B., F.R.S.
Mr. Clive Cuthbertson.
Dr. William Garnett.
Mr. Sidney Lee.
Sir Norman Lockyer, K.C.B., F.R.S.
Lady Lockyer.
Mr. N. Maccoll.
Prof. Raphael Meldola, F.R.S.
Sir Gilbert Parker, M.P.
Prof. J. Perry, F.R.S.
Sir William Ramsay, K.C.B., F.R.S.
Dr. W. N. Shaw, F.R.S.
Prof. S. P. Thompson, F.R.S.
Dr. Augustus Waller, F.R.S.
Sir Henry Trueman Wood.

The organising committee has elected Sir Norman Lockyer president, Lord Avebury honorary treasurer, Lady Lockyer honorary assistant treasurer, and Mr. C. Cuthbertson honorary secretary.

It was resolved that life members of the Guild shall pay, on admission, two guineas, which includes a registration fee of 2*s.* 6*d.*, and that annual subscribers shall pay, on admission, 5*s.*, and in each subsequent year 2*s.* 6*d.* It was also resolved that donations may be accepted.

The committee is now engaged in communicating with those corporate bodies and individuals whose support and sympathy are desired.

A general committee will be appointed, which will subsequently select from among its members an executive committee for the management of the affairs of the Guild. The executive committee will meet from time to time as their chairman may direct, and will formulate such rules as experience may suggest for the approval of the general committee.

The general committee will probably take power to appoint or approve local and special committees, which will act as branches of the Guild.

The following have already signified their general approval of the objects and proposed organisation of the Guild:—

The Right Hon. Lord Alverstone, G.C.M.G.
The Right Hon. Lord Avebury, F.R.S.
Prof. Ayrton, F.R.S.
Sir John Wolfe-Barry, K.C.B., F.R.S.
Dr. W. T. Blanford, F.R.S.
Sir James Blyth, Bart.
Mr. Brabrook, C.B.
Sir George Birdwood, K.C.I.E.
Sir John Brunner, Bart.
Sir Lauder Brunton, F.R.S.
Major-General Sir Owen Tudor Burne, G.C.I.E.
Sir Edward Busk.
Mr. R. H. Caird.
Sir William Church, Bart., K.C.B.
Sir George Sydenham Clarke, K.C.M.G., F.R.S.
The Hon. Sir John Cockburn, K.C.M.G.
Captain Creak, R.N., C.B., F.R.S.
Mr. Clive Cuthbertson.
Prof. W. E. Dalby.
Dr. Ferrier, F.R.S.
Sir Michael Foster, M.P., F.R.S.
Dr. William Garnett.
Sir Archibald Geikie, F.R.S.
Sir Robert Giffen, K.C.B., F.R.S.
Mr. Hammond-Chambers, K.C.
Prof. Herdman, F.R.S.
Prof. J. Larmor, F.R.S.
Dr. Sidney Lee.

SIR NORMAN LOCKYER, K.C.B., F.R.S.
LADY LOCKYER.
DR. LOCKYER.
MR. MACCOLL.
PROF. R. MELDOLA, F.R.S.
SIR A. NOBLE, BART., K.C.B., F.R.S.
SIR GILBERT PARKER, M.P.
PROF. PERRY, F.R.S.
SIR WILLIAM RAMSAY, K.C.B., F.R.S.
THE LORD REAY, G.C.S.I.
SIR WEMYSS REID.
SIR WILLIAM RICHMOND, K.C.B., R.A.
MR. E. ROBERTSON, M.P.
SIR HENRY ROSCOE, F.R.S.
SIR A. RÜCKER, F.R.S.
DR. W. N. SHAW, F.R.S.
MR. ALEX SIEMENS.
THE LORD STRATHCONA AND MOUNT ROYAL.
SIR L. ALMA TADEMA, R.A.
PROF. SILVANUS P. THOMPSON, F.R.S
DR. A. D. WALLER, F.R.S.
FIELD MARSHAL VISCOUNT WOLSELEY, G.C.B.
SIR HENRY TRUEMAN WOOD.

NEW REGULATIONS OF THE BOARD OF EDUCATION.

NO system of national education is complete which fails to recognise the essential importance of the work of the satisfactory secondary school. Its importance, that is, both as providing a means by which the exceptionally well endowed boys and girls of the elementary schools may continue their education under better conditions, and also as affording an adequate preparation for those pupils who later will become technical students and university undergraduates, or who will without further instruction enter upon the active duties of life. The recent Education Act gave an official recognition to what has long been urged by those who understand our educational needs, that true education from beginning to end is an organic whole. The duty has, in fact, been laid upon the Board of Education of superintending and promoting the supply by local education authorities of education other than elementary. The Board is now the final court of appeal in all matters pertaining to the administration of secondary education.

It is considerations such as these which lead us to regard the regulations [1] recently issued by the Board of Education for the government and administration of English secondary education as one of the most important of the educational documents of recent years. For, since the Board is in a position to reward by substantial grants a due adherence to the regulations here formulated, it is clear that the principles advocated officially will, whether they are right or wrong, exercise a profound influence upon the curriculum and ideals of the schools.

Such being the case, it is gratifying to find that on the whole the regulations are framed on broad and liberal lines, though, as we shall have occasion to indicate, there are dangers which it is imperative those in authority should avoid, and indications that the claim of instruction in scientific method to a place in every stage of education may be disregarded if certain phrases in the regulations are followed too literally.

It will serve to give a clearer idea of the influence the regulations are likely to exert if an attempt is made first to review some of the definitions put forward in the official publication. A secondary school is described as

"any Day or Boarding School which offers to each of its scholars, up to and beyond the age of sixteen, a general education, physical, mental and moral, given through a complete graded course of instruction of wider scope and more advanced degree than that given in Elementary Schools."

[1] "Regulations for Secondary Schools (from August 1, 1904, to July 31, 1905)." [Cd. 2128.] Price 2*d*.

Explaining what should be the characteristics of a secondary school course of instruction, the prefatory memorandum to the regulations states that it should be general, complete, and graded in its various branches. The explanation as to the precise meaning to be attached to the description "general" deserves—both because of its fairness and catholicity—to be quoted in full:—

"The instruction must be general; *i.e.* must be such as gives a reasonable degree of exercise and development to the whole of the faculties, and does not confine this development to a particular channel, whether that of pure and applied Science, or literary and linguistic study, or of that kind of acquirement which is directed simply at fitting a boy or girl to enter business in a subordinate capacity with some previous knowledge of what he or she will be set to do. A Secondary School should keep in view the development and exercise of all the faculties involved in all these different kinds of training, and will fail to give a sound general education to its scholars in so far as it sends them out, whether to further study or to the business of life, with one or other of these faculties neglected, or with one developed at the expense of the rest. Specialisation in any of these directions should only begin after the general education has been carried to a point at which the habit of exercising all these faculties has been formed and a certain solid basis for life has been laid in acquaintance with the structure and laws of the physical world, in the accurate use of thought and language, and in practical ability to begin dealing with affairs."

Secondary education such as is outlined in this paragraph will meet with the approval of every man of science. Education conducted on scientific lines is that which gives a "reasonable degree of exercise and development to the whole of the faculties." If the Board takes care that in interpreting its regulations in the schools the inspectors strive to secure this all-round, healthy mental development of English boys and girls, the hearty cooperation and sympathy of men of science may be depended upon. For to ensure the exercise and development of all the faculties, a training in experimental science is necessary, just as a course in literary and linguistic studies is essential. As the quotation shows, the Board of Education is aware that for a complete education many studies are required, each with its own object and special work. It is important to bear in mind also that the main groups of studies cooperating for the complete education of the child are of equal importance. Just as the study of literature and language can promote the growth of and strengthen some faculties to which practical studies are unable to appeal, so a training in experimental science is the best and only means of ensuring the healthy unfolding of other sides of the human brain. The classical scholar ignorant of the laws and phenomena of nature is an uneducated man, just as is a man of science who has no knowledge of the literature of his own and other countries.

This view of true education is admirably set forth in the statement prepared by the president of the British Association, and revised by a committee including the deputy Vice-Chancellor of the University of Oxford, the Vice-Chancellor of the University of Cambridge, and representatives of the modern English universities, for presentation to the Prime Minister by the recent deputation which waited upon him with reference to increased State aid for university education.

"The men upon whom the nation must chiefly depend for aid under the complex conditions of the modern world must not be entirely untrained in the study of the nature and causes of the things which surround them, or of the

forces which have to be utilised in our daily life; their training and education in humanities must also have been of the widest.

"Such men cannot be produced either by a university which neglects science or by a technical college which neglects the humanities.

"Hence the universities must be enabled to combine these two sides of a complete education, and they must also be enabled to foster research along both lines, for research is the highest and most important instrument of education, as well as its most valuable result."

And what is true of higher education is true also of secondary education upon which it rests.

It is desirable thus to recapitulate these important truths in view of section viii. of the memorandum. This paragraph is likely to lead to misapprehension and to create doubts in the minds of some men of science as to how much of the declaration of faith quoted with approval above is to be regarded as more than the mere expression of a pious hope. Section viii. informs us that all types of secondary schools fall into three main classes, and that in respect of the kind of education they offer they may be discriminated roughly as the literary, the scientific, and the commercial types of school. The boys from the literary, or first-grade school—the section goes on to explain—proceed to the university; the boys of the scientific, or second-grade school, are educated to the age of eighteen or nineteen but do not proceed to the university; the boys of the commercial, or third-grade school, leave at sixteen years of age and go into business and commerce, train to become teachers, or proceed into technical and industrial pursuits. The objects of these schools as set forth in this extraordinary paragraph must be placed before the reader:—

"The first of these paying special regard to the development of the higher powers of thought and expression, and that discriminating appreciation of what is best in the thought and art of the world, in other ages and countries as well as in our own, which forms the basis of all human culture; the second, to the training of the intellect towards understanding and applying the laws of the physical universe; and the third, to the equipment of the scholars for practical life in the commercial and industrial community of which they are members."

After studying this section one is led to believe that it has crept in by mistake; it may safely be said to have been written by somebody other than the author of the definition of general secondary education given earlier. Here we detect the old pestilent heresy that culture is the prerogative of the classical man alone, and that "a discriminating appreciation of what is best in the thought and art of the world" is forever impossible to boys from first- and second-grade schools. If the secondary education in all types of school is to give "a reasonable degree of exercise and development to the whole of the faculties," why are not all boys and girls—whether they leave school at sixteen or eighteen—each in their degree cultured?

The future in life allotted in this section to the products of each grade of school is equally preposterous. The paragraph makes it appear as if all the useful work of the world is done by people who leave school at sixteen, and as if all university men spend their lives in indulging their "discriminating appreciation of what is best in the thought and art of the world."

As readers of NATURE at least know, the sorry figure this country has cut recently in the industrial competition of the nations, and in another direction in South Africa, is precisely because of the disposition in times past, on the part of those responsible for English education, to regard "the training of the intellect towards understanding and applying the laws of the physical universe" as the work of some special kind of school instead of being a necessary and important part of every grade of education. It is surely time that it was recognised on all hands that "practical life in the commercial and industrial community" needs and deserves as good and careful an education on the part of those who pursue it as any other sphere of human activity. But, as we have said, this maladroit section viii. is an incongruity so far as the regulations as a whole are concerned, and we trust the inspectors may be instructed to ignore it.

To turn to the question of the grants to be awarded to secondary schools recognised as efficient by the Board of Education. As the sum is limited which Parliament at present places at the disposal of the Board for grants in aid of education other than elementary, the grants payable under the new regulations are to be made in respect of a four years' course only. The average age of the scholars in any class commencing the course must not be less than twelve years. The earlier education leading up to this course, and the further education, if any, given beyond it, are to be regarded as forming together with it a single organic and progressive system. Subject to certain conditions, a grant will be paid on account of each scholar attending the approved course in accordance with the new regulations on the following scale:—in the first year of the course, 40*s.*; in the second, 60*s.*; in the third, 80*s.*; and in the fourth, 100*s.*

The definition of rational secondary education occurring in the prefatory memorandum is not the only guide given to schoolmasters as to the subjects which must be taught to boys taking the grant-earning course between the ages of twelve and sixteen years. In section iv. of chapter i. the subjects of the course are enumerated. We find:—

"The course should provide for instruction in the English language and literature, at least one language other than English, geography, history, mathematics, science and drawing, with due provision for manual work and physical exercises, and, in a girls' school, for housewifery. Not less than $4\frac{1}{2}$ hours per week must be allotted to English, geography, and history; not less than $3\frac{1}{2}$ hours to the language where only one is taken or less than 6 hours where two are taken; and not less than $7\frac{1}{2}$ hours to science and mathematics, of which at least three must be for science. The instruction in science must be both theoretical and practical. Where two languages other than English are taken, and Latin is not one of them, the Board will require to be satisfied that the omission of Latin is for the advantage of the school."

Most practical schoolmasters, and men of science too if they are acquainted with the actual conditions of school work, will admit that we have outlined in these sections a rational curriculum which, in the hands of properly trained teachers, will lead to good results. We are sorry, however, to find the distinction made between theoretical and practical instruction in science; it would be better to insist simply that the time allotted to science should be devoted to experimental science. It is difficult to understand, also, why in enumerating, in section ii., the subjects of the curriculum for a course of work preparatory to that of the grant-earning years, no mention is made of science, since modern practice has demonstrated that useful preliminary work in science may be begun in the lowest forms of a secondary school.

But however admirable the regulations drawn up for the government of a secondary school, and however logical and complete the statement as to its curriculum, the success of its work in educating its pupils depends finally upon the masters to whom its work is entrusted. If these men have themselves received a broad education and have been trained for their duties along scientific lines, the boys proceeding from the school will leave it properly equipped to occupy the station to which they will be called. The training of teachers

for any and every kind of school is, in fact, the most difficult and far-reaching of all the tasks which fall to the lot of educational administrators. A second publication of the Board of Education[1] published last month assumes in consequence especial importance, and will be consulted throughout the country with the greatest interest. It is true its instructions and rules apply at present only to the preparation for their career received by teachers destined to rule in elementary schools, but it is useful as indicating the subjects which in the opinion of the Board of Education should engage the attention of the prospective teacher. Moreover, the general principles which apply to the training of teachers for elementary schools are in a large measure applicable to the professional training of their secondary school colleagues. The new regulations for the training of teachers may surely then be taken as indicating what, in the opinion of the Board of Education, should be regarded as of vital importance in any scheme for the professional preparation of every grade of teacher.

It is consequently satisfactory to find that the place of greatest prominence in the group of studies which is to engage the attention of the budding schoolmaster is given to a training in scientific method. To quote the regulations:—

"Much of the instruction which is given in all subjects must necessarily be founded upon the statements and the experience of other persons; but every education which deserves to be called complete must include some training of the student in those systematic methods of enquiry which are necessary for any assured advance in knowledge, and which are the most truly educative of all mental processes.

"If this scientific spirit is to find its right expression in the teaching given in elementary schools it must be made to imbue the whole study of the intending teacher during his course in the Training College. It must not be confined to any one branch of the curriculum. It is true that, partly as the result of tradition and partly from other reasons, the term 'scientific method' has come to be associated more particularly with the study of natural phenomena. But as a matter of fact, scientific method is of equal importance, and is indeed of ancient application, in the field of history, literature, language and philosophy; and wherever knowledge of these has made advance, it may be discerned that the essential processes of scientific enquiry have been employed."

The specific references to the kind of instruction in science which the Board intends to encourage are deserving of even higher commendation, and if these wishes are carried into effect in the colleges in the case of each and every student in training, it will not be many years before a distinct improvement will be noticed in the teaching given in elementary schools. To refer to the regulations again:—

"But in addition to all this, and particularly in view of the courses which have for many years existed in most of the Training Colleges, a certain special regard must be given to this aspect of instruction and training, in the case of the Natural Science portions of the curriculum. It is in this branch of study that the student can in some ways learn most effectively to depend in some measure upon his own powers, and discover that he need not take everything unverified and on trust upon the statement of text books or lecturers. For by wisely planned and supervised laboratory work the student may be brought into immediate touch with the facts of nature, and learn to find some things out for himself, and to form conclusions upon the results of his own observations. For these reasons the student's work in science should be so arranged that his experiments in the laboratory will precede and lead up to such generalisations in the formal lectures as can safely be established upon what the student has himself observed."

[1] "Regulations for the Training of Teachers and for the Examination of Students in Training Colleges." [Cd. 2134.] Price 4*d*.

It seems to us that the Board of Education has shown a generous appreciation of the value of scientific studies both in the professional training of teachers and in the work of the secondary school. We are promised exactly that for which men of science have frequently and consistently pleaded in these columns. It only remains now to look for the loyal cooperation of school governors and headmasters, and the reproach as to the absurdly bookish nature of English education will soon become merely a matter of history. We earnestly hope that the inspectors and other interpreters of the regulations will be inspired by the same spirit which prompted the framer of most of the sections of the prefatory memoranda to these official publications.

PHYSICAL DETERIORATION.[1]

ELEVEN months ago the large percentage of rejections for physical causes of recruits for the Army led to the appointment of this committee. The members were the clerk of the council, the inspector of physical training, and the principal assistant secretary to the Board of Education, inspectors of reformatory and industrial schools and of marine recruiting, the assistant secretary of the Scotch Education Department, a representative of the General Registry Office, and a secretary.

The committee was directed "(1) to determine, with the aid of such counsel as the medical profession are able to give, the steps that should be taken to furnish the Government and the nation at large with periodical *data* for an accurate comparative estimate of the health and physique of the people; (2) to indicate generally the causes of such physical deterioration as does exist in certain classes; and (3) to point out the means by which it can be most effectually diminished."

This committee, composed of members of high critical faculty, has been able to focus much of the knowledge of sanitary and social science of the past generation as presented to them by wisely selected witnesses, and has evidently produced an epoch-making report.

A few items from this panorama of lives of women and children of the poorest classes may be quoted as samples of the thoroughness of this report.

While bad physique practically centres round feeding, great care has been exercised in proposing the remedies for underfed children at school, and the report states:—"Education is a great social need which individual citizens are, as a rule, not able to provide for their children on a sufficient scale, but food like clothing and lodging is a personal necessity, which in a well ordered society it is not inherently impossible for parents to provide, and the effort to supplement their deficiencies and to correct the effects of their neglect should aim in the first instance at the restoration of self-respect and enforcement of parental duty."

In the course of a full memorandum by the principal lady inspector of factories referring to employment of mothers in factories and workshops, we read:—"It is impossible, however, not to be impressed by the universal preference amongst the women for factory over domestic life. I was continually being told how greatly they preferred their work in the factory to the minding of children, and how depressed and out of health they became if they were obliged to remain at home. Surprising as this appears at first, it becomes less so on consideration. At thirteen years of age the majority of these women would have begun to work in a factory, to handle their own earnings,

[1] Report of the Inter-departmental Committee on Physical Deterioration. (Eyre and Spottiswoode, 1904.) Price 1*s*. 2*d*.

to mix with a large number of people with all the excitement and gossip of factory life. They would thus in most cases grow up entirely ignorant of everything pertaining to domesticity. After marriage, therefore, it is hardly probable that they would willingly relinquish this life to undertake work of which they are in so large a measure ignorant, and which is robbed of all that is to them pleasant and exciting. Until as girls they have been taught to find a pleasure in domestic life, and until there is a greater supply of healthy and suitable recreations and amusements in the reach of all women, to counteract the prevailing squalor and gloom of these pottery towns, it is useless to expect them to relinquish factory life."

Under the heading of alcohol, its devitalising effects are duly noted, and finally attention is directed to their steady decrease owing to wise legislation in Norway and Sweden. "The reverse of the picture presented by France is complete, seeing that besides a diminution in crimes, suicides and deaths from alcoholism and syphilitic diseases, the percentage of conscripts refused has been steadily reduced, showing an elevation in the standard constitution of the people. Thus in Sweden the consumption of spirits containing 50 per cent. of alcohol in 1830 was 46 litres, and in 1890, 6 litres per head. The percentage of rejection of conscripts in 1845 was 34.46, and in 1885, 19.61."

The evidence generally is of a cogent character, and has led to many recommendations for the common weal such as seem to be at present opportune. These are summarised under no less than fifty-three headings, which fill eight pages of the Blue-book.

We may quote in full two recommendations which are made with emphasis:—

"The Committee are emphatic in recommending the creation of an Advisory Council, representing the Departments of State, within whose province questions touching the physical well-being of the people fall, with the addition of members nominated by the medical corporations and others, whose duty it should be, not only to receive and apply the information derived from the Anthropometric Survey and the Register of Sickness, but also to advise the Government on all legislative and administrative points concerning public health in respect of which State interference might be expedient; and to them might be remitted for consideration and report all the problems affecting public health which the requirements of a complex social organisation are constantly bringing to the front. Such a Council, the composition of which might be modelled to some extent on *Le Comité Consultatif d'hygiène publique de France*, would be, the Committee believe, of great assistance, especially to the Local Government Board, and would be calculated to supply the knowledge and stimulus which are necessary in order to give to the Public Health side of the Board's administration a prominence which the multiplicity of its other functions may have tended to obscure, and to attract to its work that measure of public interest and support which has perhaps been lacking hitherto."

"The Committee are emphatic in recommending that a systematised medical inspection of children at school should be imposed as a public duty on every school authority, and they agree with the Royal Commission on Physical Training (Scotland) that a contribution towards the cost should be made out of the Parliamentary Vote. With the assistance of teachers properly trained in the various branches of hygiene, the system could be so far based on their observations and records that no large and expensive medical staff would be necessary. The lines on which the inspection should be conducted are laid down in paragraphs 323-326 of the Report."

Many other recommendations like these make provision to inform the authorities; such are:—register of owners of houses; local sanitary authority to report its action or inaction to Local Government Board; Local Government Board to inform all local authorities what the law and the powers it confers are as to insanitary and overcrowded house property; infant mortality rates to be published for particular areas and for particular industries.

Educational effort is recommended with regard to:—alcoholism; rural opportunities at rural schools; food and cookery; cookery, hygiene, and domestic economy; infant feeding; training of mothers; health associations.

Games, exercises, and physical education form the subject of several recommendations.

Existing legal powers should be employed for:—the enforcement of a standard and drastic dealing with overcrowding in certain of the worst districts; smoke pollution; the remedying of the dearth of country cottages; the precautions to procure the purity of milk supply.

New powers, apparently, are called for in regard to:—labour colonies and public nurseries; smoke pollution from dwelling houses; medical inspection of factories, coal mines, workshops; provision of a grate suitable for cooking in every dwelling let for the occupation of a family; prohibiting the sale of tobacco to children below a certain age.

Upon several points the committee ask for further inquiry to be carried out—over-fatigue in women; sterilisation and refrigeration of milk; and some special subjects.

In conclusion, "the committee hope that the facts and opinions they have collected will have some effect in allaying the apprehensions of those who, as it appears on insufficient grounds, have made up their minds that progressive deterioration is to be found among the people generally. At any rate the committee believe that their labours will result in giving matter for reflection to those who realise the importance of evidence towards the determination of issues of such uncertainty and complexity, and that these persons, who they would fain hope are the larger portion of the thinking community, will await the necessary steps being taken to secure that body of well sifted and accurate information, without which it is impossible to arrive at any conclusion of value as to the general problem.

"It may be argued that there is here no immediate remedy, and that years must elapse before the lack of knowledge is supplied; but in regard to those evils the existence of which is admitted, the committee have recognised what can be done in the interval, and are confident that if their recommendations are adopted a considerable distance will have been traversed towards an amendment of the conditions they have described.

"In the carrying out of their recommendations for the rectification of acknowledged evils, the committee do not rely upon any large measure of legislative assistance; the law may with advantage be altered and elaborated in certain respects, but the pathway to improvement lies in another direction. Complacent optimism and administrative indifference must be attacked and overcome, and a large-hearted sentiment of public interest take the place of timorous counsels and sectional prejudice."

The workmanship shown in the elaboration of this report is stimulating. The recommendations bid fair to inaugurate great social amendment. They appeal to the public as much as to our legislators, and afford to all a view of many fields for doing one's duty to one's neighbour, for encouraging good local government, and for raising the standard of citizenship.

THE ESSENTIAL AUSTRALIAN.[1]

IT is not too much to say that the publication in 1899 of "The Native Tribes of Central Australia" marked an epoch in anthropological research. A lengthy residence amongst savages, who still lived in their original isolation, uncontaminated by European influences, resulted in a remarkable study of a scientific accuracy and completeness hitherto unknown. The authors, both competent ethnologists, the one a distinguished biologist, the other a protector of aborigines, were fortunate in their subject, which proved to be the most interesting section of that most interesting of all primitive peoples, the Australian race. Peculiarities of organisation and belief were revealed which threw new light on many old questions, and reversed many an old theory. In the present work Messrs. Spencer and Gillen supply a sequel to the earlier volume, completing their study of the tribes of the centre by an account of those occupying the country between the Macdonnell Ranges and the Gulf of Carpentaria. The main result is to show a fundamental agreement in important characters between all the central tribes, and the authors repeat their previous conclusion that "the central tribes which for long ages have been shielded by their geographical isolation from external influences, have retained the most primitive form of customs and beliefs." The main features of the Arunta and Urabunna tribes are recapitulated, and we are thus enabled to study comparatively the whole series. Several points in the earlier work are cleared up, and some answer to objections is given by the way. As before, the photographs are excellent and numerous. The new volume possesses the same unique character and value which were conspicuous in "The Native Tribes."

The new types of aborigines present a high average of physical development, but strike one as being less prepossessing in aspect than the Arunta. There are none of the faces which in the other book reminded one of English bishops and fellows of the Royal Society. We are struck by the great number of dialects, each of which has varieties, a fact which must have rendered the task of the investigators very difficult, were it not the case that every blackfellow is, like Ennius, the master of two languages besides his own. As before, the authors point out many fallacies in popular works. For instance, "nothing could be further from the truth" than the notion that "the various tribes were in a state of constant hostility." Again, "there is no such thing as the acquisition of fresh territory"; the blackfellow holds "not only that his country is his by inheritance, but that it would be of no use to anyone else, nor would any other people's country be any use to him." There are no chiefs or head-men; the old men constitute an informal council, which punishes crime, chiefly "bone-giving" and the breaking of marriage-laws, organises the ceremonies, and from time to time inaugurates sound reforms. There is no haranguing of the meeting, which in its etiquette and procedure is the replica of an English committee. "As to the capture of women," the authors state, "we have never in any of these central tribes met with any such thing. . . . What looks like a capture to the casual observer is in reality an elopement, in which the woman is an aiding and abetting party." A good instance this of the necessity of trained and sympathetic inquiry, going far to indicate that many of the old and still accepted theories of primitive culture may be founded on the sands of ignorant and prejudiced mal-observation.

A valuable feature of this, as of the previous work, is the way in which the daily life of the native is visualised for the reader, and in this connection there are two facts which receive especial emphasis. Before initiation, which takes place about the age of fourteen, the boy is free; after this ceremony his life is regulated for him, and is sharply divided into two spheres, the ordinary daily round of food-getting and corroborees, and "what gradually becomes of greater and greater importance to him, the portion of his life devoted to matters of a sacred or secret nature. As he grows older he takes an increasing share in these, until finally

FIG. 1.—Ceremony of Alkira-Kiuma Arunta tribe. Throwing the novice up into the air.

this side of his life occupies by far the greater part of his thoughts. The sacred ceremonies which appear very trivial matters to the white man, are most serious matters to him." They are connected with the Great Ancestors of the Alcheringa, "the dream-time," and he believes that his spirit will after death be in communion with them. "It is astonishing how large a part of a native's life is occupied with the performance of these ceremonies, the enacting of which extends sometimes over the whole of two or three months, during which time one or more will be performed daily." In one tribe there is the unique case of a ceremony performed to promote the physical and mental development of the boys and girls. Sometimes a man will, in a similar fashion, induce his bride-elect to grow, or a father will assist the development of his unborn child. In the second place, the food-supply is organised on a most effective system by the cooperation of the totemic groups. "If I am a kangaroo man, then I provide kangaroo flesh for emu men, and in return I expect them to

[1] "The Northern Tribes of Central Australia." By Baldwin Spencer, M.A., F.R.S., sometime Fellow of Lincoln College, Oxford, Professor of Biology in the University of Melbourne, and F. J. Gillen, Special Magistrate and Sub-Protector of Aborigines, South Australia. Pp. xxv+784; 2 plates, map, 315 figures. (London: Macmillan and Co., Ltd., 1904.) Price 21s. net.

provide me with a supply of emu flesh and eggs, and so on right through all of the totems. . . . It is the duty of every one to supply certain other older people with food, and this they do cheerfully and ungrudgingly. In this way and in accordance with the needs and conditions of the community, these savages have long ago settled the question of an old-age pension, or rather they have rendered any such thing quite unnecessary."

The remarkable marriage-systems of the Arunta and Urabunna are repeated with varying gradations right through the central tribes. As to the "group-marriage" of the Urabunna, the authors now state explicitly that the supernumerary husbands and wives are called *Piraungaru*, as amongst the Dieri. The present writer once compared the facts with Mr. Howitt's evidence as to the Dieri custom. The authors repeat with insistence that "individual marriage does not exist either in name or in practice amongst the Urabunna tribe." Again, "this state of affairs has nothing whatever to do with polygamy any more than it has with polyandry," a statement which I confess I do not understand. They add that this group-marriage is not abnormal, because a gradation to individual marriage can be traced among the other tribes; but what we suggest is that group-marriage is abnormal for humanity as a whole. As to the connection of totemism with the bisectional marriage-system, their conclusion for these tribes is important:—"the two systems have become associated together in various ways in different tribes, but are perfectly distinct from one another in origin and significance." The account of relationships is fuller than before. New facts as to the custom of exchanging wives are given, and in particular the account of the elaborate Fire Ceremony of the Warramunga, a typical Saturnalia, proves that one object at least of these primitive "bursts," in which everything is topsy-turvy and goes by opposites, is, as the present writer had suggested, to promote harmony and union, "to make every one good-tempered and kindly disposed."

FIG. 2.—Visit to tree grave at sunrise, a few days after the death of a man, to try and discover some clue to the supposed murderer. Warramunga tribe. The men in the tree are examining the body.

Two remarkable beliefs, which were among the new facts brought to light by the previous work, are found to prevail right through the tribes. These are the belief that each individual is the reincarnation of an ancestor, and the queer notion, difficult to regard as absolute, that the intercourse of the sexes has *nothing to do* with conception. The Urabunna and Warramunga systems necessitate that in each successive reincarnation the spirit-child changes its sex, its totem, and its moiety. There are curious folk-tales, in one of which a man propagates himself by fission, in another by a sort of budding; the hero of another shakes himself, whereupon children emanate from his muscles. We find new "totems," such as darkness, "laughing boy," and "full-grown man," which will give pause to framers of definitions of this very comprehensive term. *Intichiuma* ceremonies are actually performed by the Kaitish to increase the supply of flies and mosquitoes! Further interesting details are given as to those interesting articles, the *Churinga*, or sacred bull-roarers; in one case they are used to effect moral amelioration—to lessen a man's appetite and to make him willing to share his food with others, he is rubbed and prodded violently in the stomach with a heavy stone *churinga*. One incident of the initiation of young men among the Urabunna is a sort of tossing in the blanket—without the blanket; the patient is smacked as he comes down to a chorus of "I will teach you to give me some meat." Everyone here is a worker of magic. Husbands and wives are obtained by its means; the charms of the fair sex are literally "charms." A popular cure for head-ache or stomach-ache is to wear your wife's bonnet or its native equivalent. Among these tribes, as also shown in the earlier work, magic practically takes the place of religion. The Central Australian is a professing atheist; at initiation he learns that "the spirit creature whom up to that time as a boy he has regarded as all powerful is merely a myth, and that such a being does not really exist, and is only an invention of the men to frighten the women and children." In this connection one wonders if the Central Australian really represents a more primitive stage of culture than other savages.

A very full description is given of the tools and implements used by the natives, and of their decorative art. A remarkable application of the latter is to be found in the ground-drawings, showing considerable power of design, which are made for the numerous ceremonies.

If there is any defect in this fine monument of anthropological science, it is perhaps one that is due to its chief merit the objective character of the study; one desiderates further analysis of the psychology of the blackfellow.

Thanks to investigators like Howitt, Fison, Roth, and Spencer and Gillen, we know the Australian of the east and centre better than any savage in the world, and we may hope that our authors will be able, before it is too late, to crown their work, already invaluable, by a study of the western districts, at present a *terra incognita*.

ERNEST CRAWLEY.

THE WIRELESS TELEGRAPHY BILL.

A MEMORANDUM explanatory of the Wireless Telegraphy Bill which was introduced by Lord Stanley, the Postmaster-General, has been issued as a parliamentary paper. We have already referred to the

proposals made in this Bill in our notes columns, but a brief abstract of the memorandum and of the provisions of the Bill may be of interest to readers of NATURE. The paper opens by pointing out that the rapid development of wireless telegraphy which has been and is still going on makes some form of State control practically essential in the interests of the naval and military requirements of the Empire. The United Kingdom stands, in fact, almost alone in not having any such control; in ordinary circumstances the powers of the Postmaster-General do not extend beyond the three-mile maritime limit; although in times of war or emergency the Government can take over the telegraphic business of incorporated companies, this power does not extend to the installations of private individuals. Obviously a private individual, were he maliciously inclined, could cause a great deal of trouble with a wireless telegraphy installation in the neighbourhood of important strategical signalling stations. A certain very limited power of control exists by an arrangement already made with several foreign Powers by which these Powers undertake not to permit the establishment of systems for communication with the United Kingdom except after consultation with the British Government; this safeguard, such as it is, would naturally fail in the event of war. It is especially in the case of war that control becomes of vital importance, and it is necessary to introduce legislation to meet this event.

The points which have to be particularly considered are:—

(1) That there must be means of preventing information being conveyed to the enemy, and of preserving secrecy as to plans and preparations.

(2) That all possibility of outside interference with Government signalling must be removed.

It is therefore desirable for the Government to have in their power (*a*) the control of the transmission of messages; (*b*) the prevention of the establishment of unauthorised stations; and (*c*) the disposition of stations in the most advantageous way so as to obtain the best results in working, free from interference, accidental or intentional.

In addition to these strategic reasons other considerations make Government control of wireless telegraphy desirable, notably, for example, the advantages to be gained by international agreement on the subject, which at present the British Government could not enter into as it has not the power to enforce any agreement which might be made.

On all these grounds it is proposed in the Bill that the Government shall exercise control by granting licences; these shall be granted by the Postmaster-General, but the consent of the Admiralty and the War Office shall be necessary in order that the strategic considerations may be duly regarded. The Board of Trade is to be added as a third party whose consent is necessary; this is done because the progress of wireless telegraphy affects so closely the trade and commerce of the country. The Bill provides penalties for the unlawful establishment or working of a wireless telegraph station. It is also provided that special licences may be granted by the Postmaster-General for experimental purposes. It is understood that the Government proposes to push the Bill through this session if possible, the reason for its wishing to do so being partly that it may have power to act at the next international wireless telegraph conference, which is to be held early in October, probably at Berlin.

M. S.

NOTES.

A STANDING Committee on machinery designs has been appointed by the Admiralty. Prof. A. B. W. Kennedy, F.R.S., is to act as president of the committee; the other members will be Engineer Rear-Admiral J. A. Smith and Mr. J. T. Milton, chief engineer-surveyor to Lloyd's Register.

A REUTER telegram from Vardö, Norway, states that the relief party of the Ziegler North Polar Expedition arrived at that place on August 3 on board the steamer *Frithiof*. In consequence of fog and ice the *Frithiof* had been unable to establish communication with the expedition on board the *America*. A later telegram states that the *Frithiof* left Vardö on Friday last for Franz Josef Land.

A REUTER telegram from Wellington, New Zealand, reports that the heaviest earthquake for many years was experienced at that place at 10.22 on the morning of August 9. Several public buildings were seriously damaged, and many private firms and householders sustained heavy losses. No loss of life is reported. The shock was felt in both islands. A slight earthquake shock was also felt at Lisbon and its vicinity at 11 o'clock on the night of August 8, but no damage was done.

THE death is announced, at the age of fifty-nine years, of Dr. Carl Weigert, director of the Pathological and Anatomical Institute of Senckenberg.

NEWS of the sudden death, on the Continent, of Sir William Mitchell Banks has been received. Sir William Banks was born in 1842. He was educated at Edinburgh Academy and University, became M.D., and took the university thesis medal in 1864, and in 1899 was made honorary LL.D. He acted for a time as demonstrator of anatomy in the University of Glasgow, and settled in Liverpool in 1868 as a consulting and operating surgeon, being particularly distinguished in cancer research. Dr. Banks, who was knighted in 1899, rendered valuable service as one of the founders of the new Royal Infirmary, Liverpool, in the establishment of University College, and in the movement which resulted in the formation of Liverpool University.

MAJOR RONALD ROSS, C.B., F.R.S., and Dr. Weir Mitchell have been elected foreign corresponding members of the Paris Academy of Medicine.

THE Vienna correspondent of the *British Medical Journal* states that a meeting was recently attended by the Senate of the Vienna University to celebrate Prof. v. Vogl's seventieth birthday, and to bid him farewell on his retirement from the position he has so long held in the university. Prof. v. Vogl's successor has not yet been appointed, but he will, it is thought, probably be one of the retiring professor's former assistants.

THE sixty-first annual congress of the British Archæological Association was opened at Bath on Monday last, and will remain in session until Saturday next.

THE arrangements for the annual meeting of the Society of Chemical Industry, which is to take place in New York from September 7 to 12 next, have now been completed. The president, Sir William Ramsay, K.C.B., F.R.S., is to give an address in the gymnasium of the University of Columbia on September 8, and in the evening of that day the annual dinner of the society will be held at the Waldorf-Astoria. A tour has been arranged, to last from Monday, September 12, until Thursday, September 29, with the object

of affording members and guests an opportunity of attending the international congresses in St. Louis during the week beginning Monday, September 19. Among the cities to be visited in the course of the tour are Philadelphia, Washington, Pittsburg, St. Louis, Chicago, Detroit, Buffalo (Niagara Falls), and Boston, the last named to be reached on Thursday, September 29. Ninety-four persons, in addition to those resident in America, have already signified their intention of attending the meetings. Further particulars may be obtained from the general secretary of the society, whose address is Palace Chambers, 9 Bridge Street, Westminster.

ACCORDING to the *Pioneer Mail*, Allahabad, an irrigation conference lasting four days will assemble at Simla on September 5. Some thirty papers on subjects covering a large range of irrigation practice have been promised, and it has been suggested that if time permits the following subjects shall also be discussed:—(1) The most suitable value of "N" in Kutter's formula, for use in designing channels. (2) American practice and the two or three notions described in Mr. Kennedy's recent report, paragraphs 15–18, circulated as technical paper No. 157. (3) Distribution of water by measurement. As a basis for discussion, the remarks of the Irrigation Commission in vol. i., paragraphs 275–290, and Mr. Kennedy's memorandum, published on pp. 59–63 of the appendix, vol. iv. of that report, may be studied. (4) Loss by absorption from channels.

AN International Exposition of Hygiene is about to be held in Paris. The following congresses will take place in connection with it, viz.:—life-saving, from August 25 to 31; public health, from September 10 to 20; fisheries, from October 1 to 10; social economy, from October 11 to 20; hygiene, from October 21 to 31; and tuberculosis at a later date.

A CONGRESS of climatotherapy and urban hygiene has been arranged for at Arcachon, France. It will be held from April 24 to 29, 1905, under the presidency of Prof. Renaud, of Lyons. The general secretary is Dr. Lalesque, of Arcachon. Communications relative to the congress should be addressed to Dr. Festal, Villa David, Arcachon.

ON the initiation of the Austrian Minister of Public Instruction, an International Congress of Botany is to be held in Vienna from June 10 to 18, 1905.

THE *Novoe Vremya* states that the Medical Department of the Caucasus has decided to disinfect all letters and parcels coming from Persia to guard against the spread of cholera from Persia to Russia, and that to assist the work three sanitary bacteriological sections (each consisting of a medical man, a medical woman, assistants and sanitary officers) have been fitted out with bacteriological laboratories, disinfectants and drugs, at the expense of the Discount and Loan Bank of Persia, which is a branch of the Russian Imperial Bank. The work of organising these bodies was carried out by the Institute of Experimental Medicine.

INDIAN papers report that a provincial museum is to be erected at Rangoon, and the proposal has been made that the collections at present in the Phayre Museum shall be handed over to the Government to be deposited in the new museum. It is also proposed that the proceeds of the sale of old materials shall be applied either in adding to the collection or towards the building of a portion of the provincial museum, and that the collection shall either be kept together and be called the Phayre collection, or that the name of Sir Arthur Phayre shall be connected with some part of the new building.

THE sum of 300*l*. recently voted by the New York State Legislature for cooperative hydrographic work with the U.S. Geological Survey will, it is stated in *Science*, be used in maintaining records of the rise and fall, the ordinary outflow, floods and droughts of many streams in the State. The work has gradually grown until there is hardly a section of the State in which some river is not systematically measured, and at the present time the condition of streams in more than fifty places in the State is regularly reported.

IT is stated in the American papers that an aquarium, costing from 600,000*l*. to 800,000*l*., is to be established in San Francisco by Dr. H. Tevis in memory of his late father, Mr. Lloyd Tevis, and that plans for the building are being prepared.

THE County Council of Aberdeen has voted for another year a grant of 200*l*. to enable the Agricultural Research Association of Aberdeen to prosecute its inquiry further into a function of latent plant food in soil.

ANOTHER line of steamers—the Allan—is to have an ocean newspaper published on board its vessels. The company has, it is stated, arranged with the Marconi Company to have the most important news transmitted to its boats crossing the Atlantic, both homeward and outward bound, as soon as they come within effective distance.

THE railway department of the Grand Duchy of Baden has, says *Engineering*, presented to the Museum of Masterpieces of Natural Science and Technics at Munich an interesting collection of drawings and plans from the early days of railways. The collection includes diagrams of the first passenger and goods cars of Baden from the years 1839 to 1841, of carriages of the Nürnberg-Fürth Railway of 1837, of the Taunus Railway of 1841, of the London and Birmingham line, and further detailed diagrams of the cars of the Elberfeld experimental railway of the year 1832.

IN the latter part of 1902 arrangements were made for the establishment of a mineralogical survey in Ceylon, to last for a period of three years, the objects in view being an examination of the occurrence of economic minerals in the island with the view of their further development, and the preparation of a report descriptive of the mineral resources, as well as the arrangement of the geological collections in the museum and the accumulation of further specimens, a duplicate series being reserved for exhibition at the Imperial Institute. The report of the director of the survey for 1903 has just reached us, and tells of much work done during the period under consideration. In 1903 the area examined amounted to 512 square miles, but, as is pointed out, the work of the survey can only partially be judged by area, as in the event of the examination of important economic minerals being necessary a prolonged stay in one area may be required. At the conclusion of his report the director asks for a special grant of 1000 rupees to enable him to procure a collection of gems for the museum, the present collection being poor.

THE nature and importance of the work accomplished by the director of the Royal Botanic Gardens, Ceylon, and his staff may be judged from the report issued for last year, from which it is evident that the scientific staff is kept continuously busy in dealing with numerous inquiries and with the investigation of various horticultural problems. At the principal experiment station, Peradeniya, the treat-

ment of cacao canker has occupied considerable attention, also the value of different manures for tea plantations, and of green manures generally. The branch garden at Nuwara Eliya has been utilised for the purpose of experimenting with grasses and fruit trees upon the patana soil, and a new area of 150 acres has been reserved in the dry zone at Mahailuppalana, where cotton has already been planted, and later the cultivation of rubber and cacao under irrigation will be tried. The Government chemist, Mr. Kelway Bamber, has made an important discovery of a trustworthy test which will determine the amount of adulteration in citronella oil.

It is instructive to have the opinion of a zoologist on the results obtained by Prof. de Vries in his experiments on the production of new plant species. Prof. A. W. Hubrecht has contributed a critical review to the *Popular Science Monthly* for July which is interesting not only because it discusses the essential points of de Vries's theory, but also because the writer takes considerable trouble to show that the mutation theory modifies, but is not opposed to, the views expressed in the "Origin of Species."

In an article contributed to the *Journal of Botany* (July) Mrs. Gepp contrasts the sporangia of *Halimeda gracilis* with those of *Halimeda Tuna*, and describes the methods of communication between the central filaments in the thallus which serve as a basis for a systematic arrangement of the genus. In the same number Canon Lett describes a new hepatic, *Adelanthus dugortiensis*, from Ireland which appears to represent an ancient flora, since it has affinities with a group of hepatics found in hot climates.

An elaborately illustrated "Catalogue of Exhibits of Insect Enemies of Forests and Forest Products" at the Louisiana Exposition has just been issued by the U.S. Department of Agriculture (division of entomology), and will well repay perusal by economic entomologists and all who have to do with forestry operations. The catalogue has two indices, one of scientific and the other of common names.

The issue of the *Proceedings* of the Philadelphia Academy for the latter part of April and May contains several papers of interest. Among them is one by Mr. J. P. Moore on polychætous annelids from California, and a second, by Dr. H. C. Chapman, on the anatomy of the hyrax, in the course of which he raises the question whether the so-called "coney" of the Bible is really the Syrian representative of that group. Of more importance is the article by Mr. A. E. Brown on post-Glacial Nearctic centres of dispersal for reptiles, the title of which has been previously quoted in our columns. The absence in post-Glacial times of a circumpolar reptile fauna renders the retention of a Nearctic and a Palæarctic region convenient when discussing the distribution of this class, although this is no bar to the merging of the two into a Holarctic region for general purposes. Their present distribution points to two post-Glacial centres of dispersal for Nearctic reptiles, one in the south-eastern Austro-riparian, and the other in the Sonoran province, and temperature and humidity have been important factors in regulating such dispersals.

Vol. xl., No. 2, of the *Proceedings* of the American Academy contains an elaborate essay by Mr. G. M. Allen on the heredity of the colour of the coat in domesticated breeds of the common mouse, as illustrative of Mendelian principles. The language now used in studies of this description is so excessively technical that it is almost impossible to give a summary of the author's conclusions which would be intelligible to the ordinary reader. It has been found, however, that complete albinism is a character "recessive" towards pigmentation. The grey of the common mouse (composed of black, chocolate, and yellow) is predominant over the colours of the "fancy" breeds, so that when the latter are crossed with wild mice grey offspring result. Black mice breed true, and the "golden-agutis" also generally do the same, but may give rise to chocolate forms. The predominant grey may be produced synthetically by crossing blacks with golden-agutis, the three pigments of the former being thus brought together. Finally, black, chocolate, and the golden-aguti strains may be produced by a resolution of the original compound grey.

Another short communication to hand this week, from Reichenow's *Ornithol. Monatsberichte* for July and August, contains a continuation of Dr. J. Thienemann's observations on the birds of Rositten, dealing in this instance with the members of the crow family. The author takes the opportunity of thanking all who have assisted him in his investigations, and begs for the continuance of their kind help.

Mr. L. W. Lambe has sent us a short extract from the *Ottawa Naturalist* for 1904 in which he discusses the nature of the squamoso-parietal crest in two species of horned dinosaurs from the Alberta Cretaceous.

We have received a copy of a paper by Mr. G. H. Carpenter on injurious insects and other animals observed in Ireland during 1903, forming No. 12, part v., of the first volume of *Economic Proceedings* of the Royal Dublin Society. As was observed during the preceding year, the grubs of crane-flies (Tipulæ) are the most serious insect enemies against which the Irish farmer has to contend, although the potato-flea-beetle (*Psylliodes affinis*) did some amount of harm.

The contents of the *Entomologist* for June include descriptions of new South American beetles of the genus Chlamys by M. Jacoby, a paper on new African butterflies of the family Lycænidæ by Miss Sharpe, a supplementary list of Lepidoptera from Capri by Mr. C. S. Browne, and the continuation of a paper by Mr. P. Cameron on various new forms of Hymenoptera.

Prof. Simon Newcomb has applied mathematical analysis to an inquiry into the probability of the causes of the production of sex in human offspring. In the entire Semitic race, over the whole of Europe and America, there is a small and uniform preponderance of male over female births. There is thus on the whole a unisexual tendency in the male direction among parents of the Semitic race. In isolated families the unisexual tendency becomes more marked and may be in either direction; in some families the offspring may be either mainly male or mainly female. Among the negro race the preponderance of male over female births is either quite small or non-existent. Prof. Newcomb, analysing the data by the method of probabilities, concludes that the sex is not determined at any one moment or by any one act, but is the product of a series of accidental causes, that the functions of the father have probably little influence, the sex being determined wholly by the mother, and that it seems in the highest degree unlikely that there is any way by which a parent can influence the sex of his or her offspring. The first-born child of any mother is more likely to be a male in the proportion of about 8 to 7, and there is probably a smaller preponderance in the case of

the second child, but there is no conclusive evidence that after a mother has had two children there is any change in her tendencies.

In the *Monthly Review* for August Mr. J. E. S. Moore discusses "the cancer problem to-day," in which he details recent investigations into the cytology of malignant growths; and in the *Fortnightly Review* Dr. Alfred Mumford writes on the alleged physical degeneration of the race. The general trend of this article is that the deterioration in the vigour and health of the British race as a whole has been exaggerated, and that all the combined effort of the past for the permanent improvement of the race cannot have been without result.

At a special meeting of the Academia dei Lincei held on June 5, the results of the competition, which closed on December 31, 1902, for the royal prizes of the academy were made known. In the section of philology, a royal prize is awarded to Prof. A. Trombetti for a work on the genealogical connection between the languages of the ancient world. The prize for astronomy is divided between Prof. E. Millosevitch and Vincenzo Reina, and that for philosophical science between Prof. Sante Ferrari and Prof. Covotti. To celebrate the tercentenary of the academy, which is the oldest institution of its kind in the world, it is announced that Prof. Pirotta is preparing for publication the botanical works of Prince Federico Cesi, who, with Galileo Galilei, founded the Lincei in 1603.

In the *Physikalische Zeitschrift* (No. 15) H. Mache concludes that the emanation from the Gastein thermal spring, which is so strongly radio-active, is identical with that of radium, as the activity of both emanations decays according to the same law. Moreover, the activity induced in other bodies by the emanation from the water is of the same character as that caused under similar conditions by radium. In the same number E. F. Burton shows that the diminution in the conductivity of air enclosed in a metal vessel which is produced by surrounding the vessel with water is proportional to the thickness of the aqueous layer. The view that the radiations causing the discharge come from an external source is thus confirmed. It is also shown that, on diminishing the pressure of air in the vessel surrounded by water, the conductivity falls off continuously with the change of pressure.

In the *Physical Review* for June, E. L. Nichols and Ernest Merritt give an experimental confirmation of Lommel's contradiction of Stokes's law that, in fluorescence, the fluorescent light is always of greater wave-length than the exciting light. The variation in the intensity of the light throughout the fluorescence spectra of such substances as fluorescein, eosin, and naphthalene-red was measured by means of a spectrophotometer, and it is shown that, whatever be the wave-length of the exciting light, the curve connecting intensity of light with wave-length in the fluorescence spectrum is always of the same character. The maximum of intensity in the excited spectrum may have a wave-length much smaller than that of the exciting source. Thus in the case of eosin, with an exciting light of wave-length λ 585–605, the maximum in the fluorescence spectrum is at λ 580, the whole spectrum extending from λ 535 to λ 640.

Part ii. of the *Bulletin* of the French Physical Society for 1904 contains a description by A. Turpain of a new apparatus for cleaning large quantities of mercury. The cleaning agent is a solution of mercurous nitrate, and the mercury, after being cleaned, is dried by means of concentrated sulphuric acid, any free acid in the mercury being subsequently removed by potash. The apparatus works automatically during long periods, and needs little attention.

In the July number of the *American Journal of Science* Mr. H. A. Bumstead describes experiments on atmospheric radio-activity, which indicate that the activity acquired by a negatively charged wire exposed in the open air at New Haven, is of a two-fold character. From the rate of decay it is concluded that thorium as well as radium excited activity is present. With a three-hour exposure of the wire, 3 to 5 per cent. of the initial effect is due to the thorium activity, and with a twelve-hour exposure the thorium activity is sometimes 15 per cent. of the whole. Messrs. Trowbridge and Rollins communicate that the electrical resistance of an aluminium wire is not altered to a measurable extent when subjected to the action of radium.

The *Geographical Journal* for August contains a very clear map showing the work of the National Antarctic Expedition. The map is the work of Lieut. Mulock, R.N., who joined the *Discovery* from the *Morning* in February, 1903. The positions fixed by observations, magnetic variations, soundings, heights, and the tracks of the sledge travellers are clearly shown, as well as the track of the ship to her furthest point along the coast of King Edward VII. Land. An inset map shows the position of the discoveries with reference to the circumpolar area. The same number also contains the paper on "The German Antarctic Expedition" which was read before the Royal Geographical Society in April last by Dr. E. von Drygalski. It is illustrated by some remarkable reproductions of photographs of icebergs, &c.

The current *Century Magazine* contains two contributions which should be of interest to all students of nature, one, by that careful American observer, John Burroughs, on "What do Animals Know?" in the course of which a good deal of out-of-the-way knowledge is given in a charming manner, the other, illustrated by some striking engravings (one in colour), on "The Colossal Bridges of Utah," which deals with the wonderful arches or natural bridges that are to be found near the head of White Cañon, in San Juan County, Utah. One of these bridges, named by the discoverers the Caroline, measures two hundred and eight feet six inches from buttress to buttress across the bottom of the cañon. Its height is one hundred and ninety-seven feet from the surface of the water, while its thickness at its highest point is one hundred and twenty-five feet. The floor of the bridge is one hundred and twenty-seven feet wide, so that, as is pointed out, an army could march over it in columns of companies, and still leave room at the side for a continuous stream of artillery and baggage waggons. Two other magnificent bridges, named respectively the Augusta Bridge and the Little Bridge, are described and figured in the article, which is well worth perusal.

OUR ASTRONOMICAL COLUMN.

Ephemeris for Encke's Comet.—A set of elements for Encke's comet, corrected only for the Jupiter perturbations of the first order between 1901 and 1904, is published by MM. Kaminsky and Ocoulitsch in No. 3962 of the *Astronomische Nachrichten*. These elements are given below, together with an extract from a daily ephemeris for the period August 1 to October 16:—

Epoch and Osculation 1904 *November* 9·0 (*M.T. Berlin*).

$$\left.\begin{aligned} M &= 341^\circ\ 3'\ 39'' \\ \pi &= 159\ \ 2\ \ 39 \\ \Omega &= 334\ 27\ \ 8 \\ i &= 12\ 35\ 37 \end{aligned}\right\} 1904 \cdot 0$$

$$\phi = 57\ 54\ 20$$
$$\mu = 1075''\cdot666$$
$$\log a = 0\cdot34555$$

T = 1905 Jan. 11d. 8·8h. M.T. Berlin.

Ephemeris 0*h*. (*M.T. Berlin*).

1904		α (app.) h. m. s.	δ (app.) ° ′	log r	log Δ
Aug. 13	...	1 51 3	+21 10·2	0·3685	0·2634
,, 17	...	1 52 13	+21 45·0	0·3615	0·2421
,, 21	...	1 52 57	+22 19·8	0·3542	0·2201
,, 25	...	1 53 14	+22 55·1	0·3467	0·1970
,, 29	...	1 52 59	+23 30·4	0·3390	0·1732
Sept. 2	...	1 52 9	+24 5·7	0·3309	0·1485
,, 4	...	1 51 28	+24 23·4	0·3268	0·1358
,, 6	...	1 50 36	+24 41·2	0·3226	0·1229

THE REVISION OF THE CAPE PHOTOGRAPHIC DURCHMUSTERUNG.—In the third volume of the Cape Durchmusterung Sir David Gill referred to several lists of stars which Prof. Kapteyn had prepared in order that the objects might be re-observed and the origins of the discrepancies between the Cape and other catalogues discovered. The work of revision was commenced by Mr. Finlay, but has been continued, since 1896, by Mr. Innes. Parts i., ii., and iii. of vol. ix. of the Cape Observatory *Annals* contain the results of this revision, giving the observer's full notes and copious remarks concerning each object observed. Mr. Innes believes that not a single uncoloured star of the ninth magnitude or brighter, and south of declination −19°, is now missing from the catalogue.

Many of the questionable objects have been found to be variables or highly coloured, whilst others are fainter than the ninth magnitude. Part ii. is especially devoted to full particulars of each variable star observed at the Cape between 1896 and 1902, the elements, the curve, the region-charts, and all the available information—or references to the same—being given for each of the seventy-three objects observed.

A summary of the number of stars in the C.P.D. exhibits several interesting points. For example, whereas M. Stratonoff found that the B.D. (dec. +90° to −20°) gave a mean of 4·895 stars brighter than the ninth magnitude for every square degree, the corresponding value in the C.P.D. (dec. −19° to −90°) is 5·85. Part of this difference, at least, may, however, be due to a difference of magnitude standards. The total number of stars now contained in the C.P.D. is 91,358, and the richest region is near to η Argus, for in the −59° zone, between 10h. and 11h., there are 256 stars, or 32·7 per square degree, brighter than the ninth magnitude.

Part iii. tabulates, and comments on, the errors found by Prof. Kapteyn—and others discovered since—in other southern star catalogues for the regions south of dec. −19°, and concludes with a table of reference to all the published errata.

DETERMINATION OF LATITUDE AND ITS VARIATIONS.—In No. 3962 of the *Astronomische Nachrichten* M. E. Bijl, of the Royal Belgian Observatory at Uccle, gives the results of 685 determinations of latitude made by him during the period 1898·4–1899·5. The table given shows the time of each observation and the corresponding latitudes as deduced from the star positions given in the Berliner Jahrbuch and Newcomb's catalogue respectively. There is a constantly positive value for the difference Newcomb-B.J. of something of the order of +0″·6. The resulting latitudes show a range of about 0″·7 with a maximum at 1888·6, a minimum at 1889·0, and a lower maximum at 1889·3–1889·4.

THE STANDARDISATION OF ROWLAND'S WAVE-LENGTHS.—In an article appearing in No. 1, vol. xx., of the *Astrophysical Journal*, Prof. Hartmann answers the criticisms which have been passed on the proposals of his previous article, wherein he strongly urged the standardisation of Rowland's wave-lengths to a uniform *relative* scale. It has been urged that Michelson's absolute values should be used for the construction of an *absolute* scale, but Prof. Hartmann points out that the adoption of this idea would necessitate a wholesale revision each time a new estimate of the absolute wave-lengths was made.

In lieu of this he again suggests that the wave-length of the red line in the cadmium spark spectrum in air at +20° C. and 760 mm. pressure be adopted as λ=0438·6911 for all time, and that a coordination of a system of *relative* wave-lengths should be made with this as the standard.

The most urgent need before such a system can be completed is that an observer having the control of a large grating spectrograph shall continue Kayser's work in establishing a system of standard iron lines in the region as yet untouched by that observer. This need supplied, the values obtained by Michelson, Hamy, Fabry and Perot for a number of metals would furnish the connecting links for the completion of the proposed system.

SATURN'S NINTH SATELLITE.—From a note by Prof. E. C. Pickering in No. 3962 of the *Astronomische Nachrichten*, it appears that the position angles and distances of the satellite Phœbe, which were recently published in a Kiel *Circular*, were obtained from an ephemeris corrected to agree with the positions determined from eleven photographs obtained by Prof. Frost at Arequipa. These allowed the path of the satellite to be followed from April 16 to June 9.

DISTRIBUTION OF SUCCESSES AND OF NATURAL ABILITY AMONG THE KINSFOLK OF FELLOWS OF THE ROYAL SOCIETY.

THE result of this inquiry is to prove the existence of a small number of more or less isolated hereditary centres, round which a large part of the total ability of the nation is clustered, with a closeness that rapidly diminishes as the distance of kinship from its centre increases.

The materials are derived from the replies to a circular which I sent with a blank schedule, to all fellows of the Royal Society, asking for the names and achievements of their "noteworthy" kinsfolk in each degree of near kinship as specified in the schedule. Noteworthiness was defined as including any success that was, in the opinion of the sender, at least equal in its way to that in which the honour of a fellowship of the Royal Society is held by scientific men.

Returns are still dropping in, and now exceed two hundred. They continue to be very acceptable, but I judged it best to content myself with the number received up to a date when I could conveniently work at them, and to publish preliminary results without longer delay. The total number of returns received up to the date in question, that contained one or more noteworthy kinsfolk, was 110.

Subjoined are classified lists of the qualifications that were considered by one or other of the 110 correspondents as warrants of noteworthiness. I attached to each of these more or less noteworthy kinsmen (for my own private use in this inquiry) a *, a +, a −, or a o, signifying respectively 3, 2, 1, or no marks. In doing this, account was taken of honours, of biographical notices, and of the context of the communication, which often helped in deciding cases. Only one of these symbols was allotted to each individual.

*A List.—Mostly recipients either of a * or a +.*

Ministers of State, Heads of Departments, Permanent Secretaries, and other high posts in public offices. Member of Parliament, but subject to reservation.
Foreign Ambassador or Minister, Consul General, Secretary of Legation.
Governor of a Colony, Colonial Secretary, high Colonial Office.
Admiral or General in important command, high Staff appointments.
Clerical dignitaries, eminent ministers, philanthropists.
Legal dignitaries at home and in the colonies.
Medical men of distinction.
Professors in great universities, heads of the more important colleges and schools. University scholarships, first or second place in class lists of universities or in competitive examinations for Woolwich, Indian Civil, or principal home services.
Distinction in any form of Art—as poet, musician, singer; architect sculptor; painter, engraver, caricaturist; actor.
President or secretary of great institutions connected with science, literature, art, or purposes of public utility.
Authorship of a standard work, editorship of an important journal, authorship of valuable memoirs.
Inventor in any branch, scientific traveller.
Founder of a great business, management of great commercial undertakings, pioneer of a new industry.

B List.—Useful to corroborate and to check.

Honours: From the Crown—as knighthood and all superior orders. From public bodies—as honorary university degrees, Fellowship of Royal Society (all F.R.S. were granted a ∗), of Royal Academy, and other selected associations.

Biographical notices—as in Dictionary of National Biography and in other standard collections. Obituary and other notices in the journals of literary and scientific societies. Special memoirs. Men of the time; Who's Who?

C List.—Personal estimates taken into account.

Prominent county man. Active in public affairs, successful in business. Forward in civic matters. Good professional position. Of high repute as a scholar, &c.

D List.—Referring wholly to women.

A social leader. Great force of character. Reputed very clever. Artistic (in any way) to an exceptional degree. Successful work in educational, civic and philanthropic matters was also taken into account. Brilliant prize winnings at school or college. The following are examples of the more suggestive returns (but slightly modified). "I have no hesitation in judging her to be 'noteworthy.'" "Acquisitive mind of a high order." "Learned both Greek and Hebrew unassisted." "Had a great and recognised influence in forming the character of her (distinguished) sons." "Helped her husband greatly in his (standard) work."

E List.—Referring to youths only, and reaching at most the qualification of—

Good place in examinations, though lower than the very high ones mentioned above. School scholarships and exhibitions of fair importance.

Much less difficulty was experienced in assigning marks than had been anticipated. The totals of the number given were 183 of ∗, 188 of +, 83 of −.

The 183 ∗ included 23 fellows of the Royal Society. Brothers were only counted once.

Abbreviations used in the schedule are employed here also, to distinguish different kinds of kinship that bear the same popular names, as uncles and first cousins. They are convenient, and seem to have been easily understood. They were first suggested by me in NATURE of January 28 of this year:—*bro* = brother; *da* = daughter; *fa* = father; *Hu* = husband; *me* = mother; *si* = sister; *so* or *son* = son; *Wi* = wife. *fa bro son* means "MY father's brother's son IS"; *me da* means "MY mother's daughter IS"; *so Wi bro* means "MY son's wife's brother IS," &c.

The total amount of marks that were thus assigned to each grade of kinship are given in Table I. For example, out of the 110 *fa fa fa* of the 110 senders, 3 were allotted a ∗, 1 a +, and none a −. Out of the 110 *fa* the corresponding numbers were 27, 25, 5.

TABLE I.—*Distribution of Symbols and of Indices of Success among the Kinsfolk of the* 110 *Senders.*

Kinship	Symbols ∗	+ 2	− 1	Indices of success	Kinship	Symbols ∗ 3	+ 2	− 1	Indices of success
fa fa fa	3	1	—	11	*me fa fa*	2	1	—	5
fa fa bro	8	1	—	26	*me fa bro*	3	1	—	11
fa me bro	1	—	—	3	*me me bro*	1	1	—	5
fa fa	16	8	3	67	*me fa*	13	8	3	58
fa bro	11	15	3	66	*me bro*	11	14	3	64
fa si	1	4	1	12	*me si*	—	4	1	9
fa me	—	1	3	5	*me me*	1	3	1	10
fa	27	25	5	136	*me*	4	4	4	24
bro	37	21	17	170	*si*	3	6	5	26
Half brothers *fa son*	3	3	—	15	Half sisters *fa da*	—	—	—	—
Half brothers *me son*	—	—	—	—	Half sisters *me da*	—	—	—	—
bro son	4	11	2	36	*si son*	1	4	1	12
bro da	—	2	—	4	*si da*	1	1	1	6
fa bro son	10	7	1	45	*me bro son*	9	9	1	46
fa bro da	—	—	1	1	*me bro da*	1	1	—	5
fa si son	5	3	4	25	*me si son*	6	5	3	31
fa si da	—	2	1	5	*me si da*	—	—	—	—
son	1	16	14	49	*da*	—	6	5	17

Total 183 of ∗, 188 of +, 83 of −.

Examples:—the index for *fa fa fa* is equal to 3 multiplied into 3, *plus* 2 multiplied into 1, = 9 + 2, = 11; that for *si son* is equal to (1 × 3, + 4 × 2, + 1 × 1) = 3 + 8 + 1 = 12.

Tables II. and III. are based on Table I.

TABLE II.—*Successes of Kinsmen of Fellows of the Royal Society.*

A.—Through Male lines. Kinship	Index of successes	B.—Through Female lines. Kinship	Index of successes
fa fa bro	26	*me me bro*	5
fa bro son	45	*me si son*	31
fa fa	67	*me fa*	58
fa bro	66	*me bro*	64
	204		158

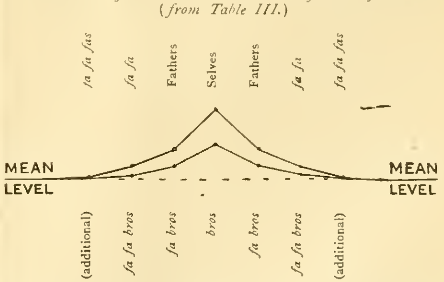
A popular notion that ability is mainly transmitted through female lines is more than contradicted by these figures.

The families of the fellows of the Royal Society must be fertile, because the number of brothers, whether of selves or of fathers, came out closely as 2·43. I will not now pursue the analysis, as the other kinds of kinship are hardly numerous enough in the present collection to justify conclusions.

TABLE III.—*Indices of Success among near Kinsmen in Ascending Generations of the* 110 *Contributors.*

Generation	110 persons in each class: Kinship	Observed indices	Accepted indices	Brothers of 110 persons in each class: Kinship	Observed indices	Accepted indices
I.	Selves	330	330	Brothers	170	170
II.	fathers	136	136	*fa bros*	66	65
				me bros	64	
III.	*fa fa*	67	62	*fa fa bros*	26	16
	me fa	58		*me me bros*	5	
Additional	*fa fa fa*	11		*fa me bros*	3	
				me me bros	5	

Distribution of Success in the Families of Successful Men (*from Table III.*)



The upper line of the diagram indicates the successes of direct male ancestors, the lower line those of their brothers. The mean level of the community was inferred from the fact that it cannot be higher than the lowest entries in Table III., so far as these are to be trusted, and that these would be of barely perceptible magnitude in the small diagram.

Relation of Success to Natural Ability.—The success of

a man is wholly due to the combined effect of Natural Gifts and of Circumstances. More, however, being included under the title of natural gifts than can influence success, this part may be disregarded. The remainder comprises intellectual power, appropriate tastes, a persevering disposition, and much else, forming a large group which will be briefly termed "Natural Ability." The Circumstances, so far as they affect success, include healthy rearing, family and social influences, education, money, leisure, and surroundings that encourage work or idleness.

Men whose histories are known can be sorted with rough fairness, and with little difficulty, into three grades of natural ability, one-third of the whole number being classed as "above mediocrity" and marked +1, another third being classed as "mediocre" and marked 0, the remaining third being classed as "below mediocrity" and marked −1. After this has been done and the results recorded, the same men may be sorted afresh and independently into three grades, according to their Circumstances, one-third of them consisting of those whose circumstances conduced to success and are marked +1, the other thirds being respectively marked 0 and −1 on the principle already explained. Assuming for the moment (the question will be discussed later on), first, that Natural Ability and Circumstance are independent, and, secondly, that the mark for Success will always be equal to the sum of those for Ability and Circumstance, then the relation of Success to Ability is easily found. A square table (Table IV.) is made with three columns and three horizontal bands; it consequently contains nine compartments. The "arguments" at the head of the several columns will be +1, 0, −1; so will be those that precede the several bands. Then an entry is made in each compartment equal to the sum of its two arguments. The next step is to sort the successes in order of their values, annexing to each the various grades of ability that have been associated with it, and to enter the averages of them at the side as in Table V.

TABLE IV.—*Distribution of Successes, under the assumption that each differs little from that of the sum of its two variable constituents, and that these vary independently.*

Circumstance	Natural ability		
	+1	0	−1
+1	+2	+1	0
0	+1	0	−1
−1	0	−1	−2

The entries in the body of the table represent the Successes. Each is the sum of its two arguments, which refer respectively to Natural Ability and to Circumstance.

TABLE V.—(*Extracted from Table IV.*)

Grades of success	Associated grades of natural ability			
	All of the observed values			Average values
+2	+1	—	—	+1
+1	0	+1	—	$+\frac{1}{2}$
0	−1	0	+1	0
−1	−1	0	—	$-\frac{1}{2}$
−2	−1	—	—	−1

The result is that the average quantity of exceptional ability which is associated with any given amount of exceptional success is exactly its half. This same conclusion is reached by an *a priori* argument. Thus, let S, A, C be three independent variables, and $S=\frac{1}{2}(A+C)$. Then if C be unknown, its *average value* will be mediocrity, that is, $=0$. Consequently S will *on the average* be associated with $\frac{1}{2}(A+0)$, that is, with $\frac{1}{2}A$. There is a uniform rate of regression towards mediocrity. The same will take place if the cases are sorted in such proportions that the mediocrities shall be twice as numerous as either of the extreme groups. The table will then have four columns and four bands, with the arguments +1, 0, 0, −1, and it will have sixteen compartments. The result will still be the same if the mediocrities should be thrice as numerous as either of the extreme groups, and so on.

The two assumptions that have been made with the purpose of giving a rough idea of what would really occur must now be justified so far as may be. The first assumption was that natural ability and circumstance may be treated as *independent* variables. This position would be indefensible if we were making a precise analysis, because the two are certainly correlated to some extent. Thus a bright attractive boy receives more favour, and thereby has more opportunities of getting on in life, than a dull and unpleasing one, but these advantages are not unmixed with drawbacks; attractiveness leads to social distractions, such as have ruined many promising careers. The amusing couplet of Henry Taylor is worth quoting:—"Me, God's mercy spared, from social snares with ease Saved by the gracious gift, ineptitude to please." Another instance of correlation is that the disposition to intellectual effort being heritable, a naturally studious boy is frequently brought up in a family whose influence and opportunities develop his natural bent; similarly as to natural scapegraces. But my returns here and elsewhere show that home influences are much less potent than might be supposed. Many correspondents speak of themselves as the only members of their family who had tastes like their own, and kinsfolk win distinction in many different directions. Moreover, a reaction against the monotony of home influences is often shown by those strong characters whose tastes are not in complete harmony with them. The correlation between natural aptitude and the circumstances favourable to success is consequently less strict than appears at first sight, and to the best of my judgment is not worth regarding in a rough inquiry.

The other assumption was that success is equal to the simple sum of natural ability and favouring circumstance. On the contrary, it must be some highly complex and discontinuous function of it. Still, the fact remains that a gifted child is more likely to succeed under conditions that are on the whole favourable to success than otherwise. The obvious objection that circumstances favourable to the development of one class of mind may be prejudicial to that of another is met by supposing a preliminary grouping of the men according to their dominant tendencies, scientific, scholastic, artistic, devotional, militant, and so forth, and treating these groups separately, each with its appropriate classification of circumstance. Little more is asked for than that natural ability and circumstance, as reasonably interpreted, shall be considered *cumulative*, in a broad and general sense, in their power of leading to success. It follows from this that any "exceptionality" of natural ability will, on the average, be roughly proportional but inferior to the exceptionality of the accompanying success. Also that the two will agree in direction, good ability going with high success, poor ability with the reverse. Rare exceptions do not invalidate general conclusions, any more than the fact of one boy in a class of schoolmates dying very early or very late invalidates the expectation of life at school ages as calculated by actuaries.

Exceptionally Gifted Families.—The diagram would assure us, even if we had no other grounds for assurance, that exceptionally gifted families must exist, whose race is a valuable asset to the nation. A few of these have been indicated by the present returns; they well deserve, and will probably receive, a full description hereafter. It must suffice for the present to mention the existence of at least nine gifted families connected with fellows of the Royal Society, two or three of whom are exceptionally gifted. I will conclude with the remark that the experience gained through this inquiry has strongly confirmed an opinion expressed in my lecture on Eugenics before the Sociological Society, of which an abstract appeared in these columns (vol. lxx. p. 82), namely, that it would be both feasible and advantageous to make a register of gifted families. I have now better hope of being able to carry some such design into effect.

FRANCIS GALTON.

THE HEALTH CONGRESS AT GLASGOW.

AT the congress of the Sanitary Institute recently held at Glasgow, a large number of sanitary officials, delegates from sanitary authorities, and others interested in public health matters assembled, and a busy four days of discussions were relieved by a generous programme of local entertainments. Glasgow is an excellent centre for such a meeting. The hospitality of the city is proverbial, and the enlightened enterprise of the corporation and its officials in dealing with the sanitary needs of "The Second City in the Empire" is generally recognised. The city abounds in interest to those who appreciate what a far-sighted and energetic civic management of affairs has achieved in the direction of solving the many public health problems which present themselves in every large industrial community. An enlightened municipality has provided an excellent system of electric trams, and acquired its own water supply and lighting; four public abattoirs have been established, and private slaughter-houses abolished; and hospital accommodation amounting to $1\frac{1}{3}$ beds to every 1000 of the population has been provided for the infectious sick. But the energy and wisdom which have characterised the civic management of affairs is in no respect better evidenced than by the circumstance that in comparatively recent years no fewer than fifteen parks or open spaces, together amounting to more than 1000 acres in area, have been procured as lungs for the city. There is, indeed, no form of municipal enterprise in the interest of public health, however recent or advanced, which has not been adopted and put to the test in Glasgow; and hence the attractiveness of the city to the hygienist and to the earnest municipal representative. Model lodgings for the poor and labourers' dwellings now replace some of the insanitary property which has been demolished; the corporation owns a municipal infants' milk depot, reception houses for the temporary detention of those who have been in close contact with certain of the infectious diseases, municipal chemical and bacteriological laboratories, public baths and wash-houses, and it has recently had the courage to demand the closing of the public houses at 10 p.m. Drunkenness is very prevalent in Glasgow, and the more drunkenness can be reduced the easier does the solution become of most public health problems.

Despite all this good work, the conditions under which so many of the poor are still housed in Glasgow continue to demand the exercise of much energy and enterprise on the part of the local authority. A tremendous amount of "spade-work" still remains to be done, and it is not easy to contemplate the state of things which would now exist if the corporation had shown less wisdom and vigour in dealing with the poorer section of the community in the past, for few, if any, cities of Great Britain have stood more in need of enlightened administration. Glasgow is essentially a manufacturing and trading community. A city cannot be this and beautiful at the same time. It has an atmosphere in which poverty, dirt, and intemperance naturally take root and thrive. But the corporation has proved itself to be quite wide awake to the wants of Glasgow, and it is administering to those wants with no niggard hand. Would that it could deal effectively with those pernicious individuals who fatten on the poorest section of the community by the system of "farming" tenements, and would that it could succeed in abolishing that almost essentially Scotch custom of placing beds in air-stagnant recesses in the walls of living rooms, for it is not easy to exaggerate the harmful effect the custom must have upon the public health.

It is, of course, impossible within the limits of a short article to deal adequately with the extensive programme of work performed at the congress. Figuring most prominently among the more important subjects which came under discussion were those of the milk supply, the disposal of sewage, the housing of the poor, infant feeding, school hygiene, the hospital isolation of infectious disease, and disinfection.

Dissatisfaction was generally expressed at the lack of suitable precautions to guard our milk supply from contamination, and there was a general conviction that this circumstance was responsible for much preventable infantile mortality. The same unanimity was not accorded to the subject of the value of hospital isolation of scarlet fever patients, and this was responsible for a lengthy discussion at the conference of medical officers of health. There is a considerable body of expert opinion opposed to the present wholesale and indiscriminate hospital isolation of this disease, which now generally assumes so mild a type. Hospital isolation seems incapable of materially reducing the attack rate among the community, and so few children escape attack altogether that the good obtained is disproportionate to the enormous expense entailed, and therefore the restriction of the number of cases admitted to hospital to those who cannot possibly be nursed at home without great risks, is advocated by many. This restriction, strictly enforced, would reduce the number of admissions by some 50 per cent. in many large towns, and the money thus saved could be spent with far greater effect upon other public health measures.

Many of the papers contributed to the congress dealt with controversial subjects, and contained nothing of scientific value; these contributions, however, serve a most useful purpose at such meetings, for the adoption or otherwise of administrative measures of public health importance is largely determined by the trend of the general discussions which they evoke.

Reference may be made to one or two of the more practical papers which were of general interest.

In a paper read by Dr. R. H. Crowley upon the spread of diphtheria in schools, it was pointed out with reference to a school outbreak of this disease in Bradford that whereas the throats of ninety-three scholars gave no clinical evidence of diphtheria, in forty-two instances diphtheria bacilli were present; and the importance of such an examination and the necessity of isolating scholars who, though apparently healthy, contain the germ on their throats during such outbreaks were emphasised.

Dr. Louis Cobbett, in another paper, concludes from the result of his experience in the Chelmsford and Cambridge outbreaks of the disease that diphtheria bacilli in healthy persons are only to be found among such as have come into contact with cases of diphtheria, and possibly also in those who have come into contact with healthy people who harbour the bacilli, and he advocates that all sanitary authorities should have at their disposal the services of a skilled bacteriologist.

Dr. A. Greenwood brought before the notice of the congress the results of his examination of the air of certain school class-rooms in Blackburn. He found that the average amount of carbon dioxide (CO_2) present in the air of Blackburn was 4·37 per 10,000, whereas that of the air of Blackburn schools was 9·69. This amount of vitiation of the air in the class-rooms of schools is doubtless very general, and improved means of ventilation are demanded in the interest of scholars.

Dr. H. Wright Thompson gave the results of his examination of the eyes of 750 Glasgow school children. He found that 34·2 per cent. of the 600 Christian children were in need of medical ophthalmic treatment, and that 47·6 per cent. of the 150 Jewish children required such treatment. So far as eyesight is concerned, Glasgow children are in a worse condition than those in either Edinburgh or Aberdeen.

Mr. W. C. Tyndale and Lieut.-Colonel Davies, R.A.M.C., in a paper recording valuable experimental work (including suitable bacteriological experiments), conclude that when the surface of a chalk formation is deluged with sewage, traces of sewage, as evidenced bacteriologically, may penetrate to a considerable depth, but that when sewage is applied in an ordinary and reasonable way over the surface no such contamination of the subsoil takes place.

Prof. Kenwood and Dr. Allan, in dealing with practical disinfection, furnished the results of experiments upon the disinfecting action of certain disinfectants after being exposed for four weeks to the air. The results show a considerable loss of power in most instances, even in the case of carbolic acid.

A rather sensational paper was read by the chief sanitary inspector for Glasgow, Mr. Peter Fyfe, upon the result of the examination of certain flock material taken from mattresses. This material is sometimes made from rags and cast-off clothing sorted from ash-pits, &c., and the bacteriological examination of the flock taken from some recently purchased mattresses disclosed an amount of un-

cleanliness in the form of live potential dirt that is unpleasant to contemplate, and is not without its dangers. The results of the examination revealed a state of affairs which calls for remedial action.

The usual exhibition of sanitary apparatus and appliances was held in association with the congress, and a new feature, which certainly met with an encouraging amount of success, was the delivery, each evening, of free popular lectures upon different items of general hygiene.

INDIAN IRRIGATION AND ITS RELATION TO FAMINES.

IN the summer of 1901 the Governor-General of India in Council decided on the formation of a special commission to report on the irrigation of India as a protection against famine.[1]

The commissioners appointed were Sir T. Higham, M.I.C.E., Inspector-General of Irrigation; the Hon. Denzil C. J. Ibbetson, Chief Commissioner of the Central Provinces; the Hon. J. W. P. Muir Mackenzie, Secretary to the Government of Bombay; Diwan Bahadur Mudaliar, member of the Legislative Council of Madras; with Sir Colin Scott Moncrieff as president, and Mr. W. B. Gordon, M.I.C.E., as secretary. Their first meeting was held at Lahore on October 29, 1901. Two years were spent in inspecting all the principal irrigation works, and their report was presented to Parliament a short time ago in the form of a Blue-book.

About the same time the Department of the Interior United States Geological Survey sent Mr. Herbert M. Wilson, one of their staff, to India to investigate the method of irrigation as carried out there, and to obtain such information as might be of use to the department charged with the irrigation works in the western States and the reclamation service of the American Geological Survey.

His report, entitled "Irrigation in India,"[2] was published in 1903. Largely as the result of the renewed activity in irrigation in America, the first edition of the report was soon exhausted, and a second edition revised up to date has been issued.

India stands preeminent in the gigantic engineering undertakings carried out for irrigation purposes. No other country has so vast and so fertile an expanse of territory with such convenient slopes for the construction of canals, and at the same time such an abundant though varied water supply.

The main factors determining the use and value of irrigation are the rainfall, the character of the soil, and the class of crop best suited to the special conditions prevailing.

In India the zone of heaviest rainfall lies along the western coast of the main peninsula, where the monsoon striking the western Ghats precipitates on their outer slopes an average annual rainfall of 100 to 250 inches. On the outer ranges of the Himalayas the annual rainfall amounts to 461 inches. Over the greater part of India, however, the rainfall is below 40 inches. In the extreme south of the peninsula it is scanty and precarious, and in some of the States of the north-west the average annual fall is as low as 5 inches. Where the annual rainfall is below from 10 to 12 inches cultivation is practically impossible without irrigation. Where it is abundant and exceeds 70 inches the chance of the failure of the crops may be regarded as so remote as to make irrigation unnecessary. Between these two extremes lies a vast tract of nearly a million square miles of which, in the absence of irrigation, no part can be deemed absolutely secure against the uncertainties of the season and the scourge of famine.

On the irrigated lands two crops can be taken in the year, one of which is sown in the early spring and gathered in the autumn, and the other sown in the autumn and gathered in the spring. The summer crop depends little on irrigation for its maturing, as this is growing during the monsoon or rainy season. The autumn crop consists of millet, pulses and rice, and the spring crop of wheat, barley, linseed and grain. The crops mainly dependent on irrigation to ensure a full return are wheat, barley, sugar cane, garden crops, and cotton where it grows on the black soil. The area under wheat covers more than 16 million acres, and that on which cotton is grown $8\frac{1}{3}$ million acres. Rice is an extensively cultivated crop, but is principally limited to the delta lands of the Orissa, Godaveri and Bengal; 80 per cent. of the crops raised in such regions are rice. Millet and oil seeds also are important crops. All kinds of vegetables and fruit are produced, these being the chief food of the natives. Jute is very extensively grown, the largest imports to this country coming from India. Indigo is also largely grown by the natives, and poppies for the production of opium. Tobacco and coffee are only grown in small quantities. Tea is extensively grown in Assam, where it is indigenous, and also in Darjeeling.

Irrigation has been practised in India from time immemorial. Many of the large tanks or storage reservoirs date back to the eighth and ninth centuries. The Grand Anicut in Madras is supposed to have been made in the second century. A canal on the banks of the Jumna made by the former rulers was restored in 1814, and the experience gained in this work led to the construction of the great Ganges Canal, a work which in magnitude and boldness has not been surpassed by any irrigation work.

The total length of the Government irrigation canals, including branches, is 36,000 miles, and they can discharge more than 100,000 cubic feet of water a second, and irrigate annually 19 million acres. There are also 7000 miles of minor protection works and storage reservoirs with a capacity of 25,000 million cubic feet.

The total area in India irrigated is estimated at 44 million acres, of which 42 per cent. is supplied with water from State works, $15\frac{1}{2}$ millions being from canals, and 3 millions from reservoirs. Of the private works, covering $25\frac{1}{2}$ million acres, 2·8 per cent. is from canals, 11·8 from tanks, 29·2 from wells, and 14 from other sources.

The capital outlay on the thirty-nine canals and major works up to the end of 1901 was more than $36\frac{1}{2}$ millions of pounds (counting a lakh of rupees as equal to 10,000*l.*). The annual revenue after paying all working expenses was 7·1 per cent. The works in the Punjab yield a net revenue of $10\frac{1}{2}$ per cent.; those in Bombay and Bengal do not earn enough revenue to cover interest charges on capital outlay.

The value of the crops irrigated in a single year is about equal to the whole capital cost of the works, and in time of famine the produce of the irrigated area being largely available for transport to distressed districts becomes an important item in the general food supply of the country. The irrigation works have also been largely instrumental in relieving congested districts. Some of the great canals in the North-West Provinces and the Punjab were undertaken in districts that were sparsely inhabited; within ten years from their construction the country became fully populated.

With regard to the value of irrigation works in mitigating the horrors and cost of famines, in the Sholapur district, where four famines have occurred since 1846, and where the cost to the State of the last two famines in 1896 and 1899 was equal to 1,150,000*l.*, the estimated loss is reckoned at 50,000*l.* a year, which, capitalised at 4 per cent., amounts to $1\frac{1}{4}$ millions of pounds as the limit of unproductive expenditure that might be incurred for the sake of avoiding the future cost of famine relief for this district alone. During the terrible famine of 1876, for which a large relief fund was raised in this country, $5\frac{1}{2}$ million of lives were lost, although the Indian Government expended 11 millions of pounds in relief.

Many of the great works already undertaken have been the direct outcome of famines. The great famine of 1837 in Bengal led to the project of the Ganges Canal, which has now 5500 miles of main canal and branches; the famine which desolated Orissa and the north of India in 1864, when a million of the inhabitants lost their lives by starvation, notwithstanding the expenditure of upwards of $6\frac{1}{4}$ millions of pounds in combating the famine, and also more than 3 millions in works of irrigation, resulted in the policy since adopted of systematically carrying out extraordinary public works and expending half a million a year in developing

[1] Report of the Indian Irrigation Commission, 1901–3. Part i. General. (Eyre and Spottiswoode). Price 1*s.* 4*d.*

[2] "Irrigation in India." By Herbert M. Wilson. (Washington: Government Printing Office.)

irrigation for the purpose of preventing the recurrence of these terrible disasters.

As the result of its investigation, the commission found that in the several districts it visited a programme of works had been prepared for work in such proportion of the population as is likely to be affected by famine, and that it was claimed that most of these works would be of a useful character; but the commissioners were of opinion that the degree of utility likely to be attained must for the present be regarded as uncertain, many of the works having been hurriedly selected. In addition to irrigation, the works included roads and railways.

The commissioners also recommended a very extensive programme of protective irrigation works to be constructed as rapidly as may be practicable in the tracts that are most likely to suffer from famine. They also endorse the recommendation of the Famine Commission of 1901, that greater reliance should be placed in future on village works as a means of employing relief labour than has been the practice in recent famines. They, however, advise the use of caution, and express the opinion that no relief labour can be more useless than that expended on works which, however useful if eventually completed, will probably remain as a famine folly, incomplete for ever.

They strongly recommend that a central board should be constituted, and invested with the responsibility of regularly watching and reporting progress as to works set out in the programme laid down, and of guarding against material deviations from the working plans of each province being made without the express sanction of the Government.

For the prosecution of their programme of new State irrigation works, it is pointed out that a large and permanent increase will have to be made in the strength of the engineering establishment.

The general conclusion arrived at is that there is a wide but not unlimited field in which the engineers and civil officers can work together for the protection of the country from famine, partly by the construction of new State irrigation works, and partly by encouraging and stimulating the extension of irrigation by means of private works. Both methods will involve heavy expenditure on the part of the State, upon which there may not be any direct return, although it may be justified by the value of the protection afforded. While the whole of India can never be protected from famine by irrigation alone, yet much can be done to restrict the area and to mitigate the intensity of famine. Any enduring success of works carried out will depend no less on their effect in evolving a spirit of self-help and thrift among the people than in their efficiency in securing crops from drought.

Mr. Wilson's report is of considerable value to engineers engaged in irrigation works, as it contains a great deal of information relating to constructive works, such as weirs, sluices, and dams, and also descriptions, accompanied by illustrations, of many of the principal irrigation works carried out in India.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following re-appointments for three years have been made:—Dr. A. J. Herbertson, to be lecturer in regional geography and curator of the School of Geography; Dr. G. B. Grundy, to be lecturer on ancient geography; Mr. C. R. Beazley, to be lecturer on the history of geography.

DR. REGINALD BULLER, lecturer on botany in the University of Birmingham, has been appointed professor of botany in the University of Manitoba.

THE Salters' fellowship of the Pharmaceutical Society has again been conferred on Mr. J. Stuart Hills, who since October, 1903, has devoted himself entirely to research work.

DR. A. W. CROSSLEY, lecturer in chemistry at St. Thomas's Hospital Medical School, has been appointed to succeed Prof. W. P. Wynne, F.R.S., in the chair of chemistry in the School of Pharmacy of the Pharmaceutical Society of Great Britain, and the following demonstrators have also been appointed in the latter school:—Mr. F. G. C. Walker in chemistry, Mr. J. T. Cart in pharmaceutics, and Mr. T. G. Hill in botany.

THE Drapers' Company has discharged the debt of University College, London, to the bankers to the amount of 30,000*l*. The treasurer has received from Messrs. Wernher, Beit and Co. their cheque for 10,000*l*., promised to promote the incorporation of the college in the university. For the completion of the incorporation scheme, there yet remains the sum of 18,000*l*. to be raised. Prof. Oliver has been re-appointed to the Quain chair of botany. Dr. F. J. Poynton has been appointed sub-dean of the faculty of medicine in succession to Prof. G. D. Thane, resigned. The session 1904–5 will begin, in the faculties of arts and laws and of science, on Tuesday, October 4, and in the faculty of medicine on Monday, October 3. The introductory lecture will be given by Prof. J. Norman Collie, F.R.S., on October 3, at 4 o'clock.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 2.—"The Advancing Front of the Train of Waves Emitted by a Theoretical Hertzian Oscillator." By A. E. H. **Love**, F.R.S., Sedleian Professor of Natural Philosophy in the University of Oxford.

The waves emitted by Hertz's oscillator have been identified with those due to a vibrating electric doublet. The field due to a variable doublet is expressed by equations of the form

$$\left.\begin{aligned}(X, Y, Z) &= \left(\frac{\partial^2}{\partial x \partial z}, \ \frac{\partial^2}{\partial y \partial z}, \ -\frac{\partial^2}{\partial x^2}-\frac{\partial^2}{\partial y^2}\right)\frac{\psi(ct-r)}{r} \\ (\alpha, \beta, \gamma) &= \frac{1}{c}\left(\frac{\partial^2}{\partial y \partial t}, \ -\frac{\partial^2}{\partial x \partial t}, \ 0\right)\frac{\psi(ct-r)}{r}\end{aligned}\right\}$$

in which c is the velocity of radiation, and $\psi(ct)$ is the moment of the doublet at time t. When there is damping ψ has the form

$$\psi = Ae^{-\frac{\nu}{\lambda}(ct-r)} \sin \frac{2\pi}{\lambda}(ct-r+\epsilon),$$

where λ is the wave-length, A a constant depending upon the amplitude of the vibrations, ϵ a constant expressing the phase, and ν a constant expressing the damping. According to the experiments of Bjerknes, ν may be taken to be about 0·4 when the wave-length λ is about 10 m. The constant ϵ is determined by the conditions which hold at the front of the waves ($r=ct$). The field outside

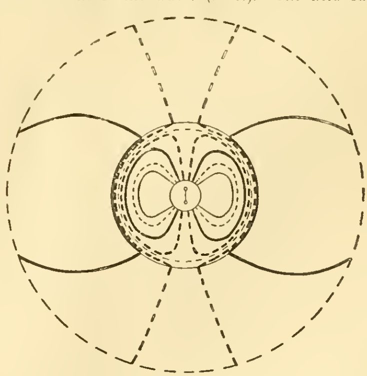


FIG. 1.

this surface is that which is established at the instant when the vibrations begin. At this instant the brass balls of the oscillator are so highly charged that the electric strength of the air between them gives way. The initial field is that due to the charges at this instant, so that it can most appropriately be represented as the electrostatic field of a fixed doublet.

It is shown that the moment of the initial doublet is the maximum moment of the vibrating doublet, and that ϵ is given by $\tan\frac{2\pi\epsilon}{\lambda}=\frac{2\pi}{\nu}$.

The effect of the introduction of the phase-constant ϵ is discussed in detail, and the advance of the waves through the pre-established electrostatic field is illustrated by a number of figures. For example, Fig. 1 here shows the lines of electric force after an interval of (0·51) of a period from the beginning of the vibrations, the fine continuous circle representing the front of the waves. Fig. 2 shows

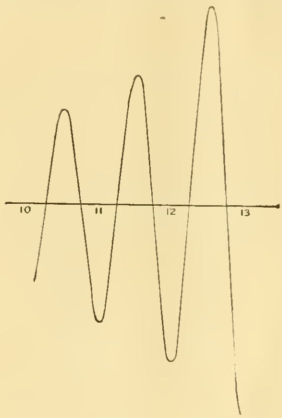


FIG. 2.

the transverse electric force at distances between 10 and 13 wave-lengths from the doublet at the end of 13 periods. Outside the front of the waves, when this front has travelled so far, the electric force is extremely small. Hence the marked discontinuity of the figure at $r = 13\lambda$.

June 16.—"The Absorption and Thermal Evolution of Gases Occluded in Charcoal at Low Temperatures." By James **Dewar**, M.A., D.Sc., LL.D., F.R.S.

"The Direct Separation of the most Volatile Gases from Air without Liquefaction." By James **Dewar**, M.A., D.Sc., LL.D., F.R.S.

PARIS.

Academy of Sciences, August 1.—M. Mascart in the chair.—The general organisation of solar researches. The continuous registration of the variable elements of the sun: H. **Deslandres**. The author summarises the actual position at the present time of researches on the sun, systematically carried out, and suggests further organisation of the work.—The synthesis of several alcohols in the cyclohexane series: Paul **Sabatier** and Alph. **Mailhe**. Starting with cyclohexane, which can be readily prepared in quantity by the method previously described, this is converted into the monochloroderivative, and this made to react with magnesium. By acting upon this magnesium compound with various aldehydes and ketones, and decomposing the resulting product with water, several new alcohols have been isolated.—The characteristics of anachoropteridian leaf traces: C. Eg. **Bertrand** and F. **Cornaille**.—Observations of the sun made at the Lyons Observatory with the Brünner 16 cm. equatorial during the first quarter of 1904: J. **Guillaume**. The results are given in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—On the zeros of integral functions: Pierre **Boutroux**.—On the indirect measurement of the real velocity of aërial vessels: Paul **Renard**. The absolute velocity of an airship, U, is the resultant of the velocity of the wind, V, and the real speed, W. A new method of estimating the latter is given.—On the theory of helices capable of supporting a weight: Edgar **Taffoureau**.—On the coefficient of rectilinear diameters: E. **Mathias**.—On the index of refraction of solutions: C. **Chéneveau**. A reply to the criticisms of Edmond Van Aubel on a former paper of the author.—On the mercury thermal ammeter: C. **Camichel**. The method employed consists in heating for one minute, by a continuous current, a mercury resistance placed in the inside of the bulb of a mercury thermometer, the latter radiating to a surrounding vessel maintained at the melting point of ice. The apparatus described gave a displacement of 145·3 divisions with a current of 1·588 amperes. Under these conditions, an increase in the intensity of the current of 0·01 ampere produced a rise of two divisions on the scale.—The action of ammonia upon boron bromide and on phosphorus trichloride: A. **Joannis**. The action of ammonia upon boron bromide depends upon the temperature, an amide being obtained at $-78°$ C., the imide at $-10°$ C. Phosphorus trichloride at $-78°$ C. gives a mixed amido-imide, possibly $NH{=}P{-}NH_2$.—The estimation of bismuth by electrolysis: A. **Hollard** and L. **Bertiaux**. Details are given of a method for separating small quantities of bismuth electrolytically in the presence of considerable quantities of copper or lead. Test experiments show the degree of accuracy obtainable.—On the existence of three kinds of phagocytic cells in normal Amphipoda: L. **Bruntz**.—On the urns of *Sipunculus nudus*: F. **Ladreyt**. These are not phagocytes nor parasites, but are detached from the body of the animal.—On a hemogregarian of *Psammodromus algirus*: H. **Soulié**.—On the structure of the crystalline medium: G. **Friedel**.—On the Callovian layers of the Morocco frontier: Louis **Gentil** and Paul **Lemoine**.—On the eruptive rocks described by the Niger-Bénoué-Tchad mission: Henry **Hubert**.—New observations on the alteration of level of the Mediterranean: Ph. **Negris**. From a study of an ancient bridge at Leucade the author concludes that the level of the Mediterranean is at present about 3 metres higher than it was at the time of the Romans, or about 2000 years ago.—Researches on animal lactase: H. **Bierry** and M. **Gmo-Salazar**.

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Rayleigh

THURSDAY, AUGUST 18, 1904.

SCIENTIFIC WORTHIES.

XXXIV.—LORD RAYLEIGH.

LORD RAYLEIGH'S investigations have covered so wide a field, and the advances he has made in every direction have been so marked, that it is no easy task to give an account of them in a short notice.

He has left his impress on all branches of physical research, an impress distinguished by the thoroughness and completeness of his work, by his skilful adaptation of means to ends, by a keen insight into the essentials of a problem, and by a strong grasp of the fundamental principles required for its solution.

Whether it be in his early work before the days when he held the Cavendish professorship, in the series of electrical measurements that marked his short tenure of that post, or in the discoveries made more recently in his own laboratory at Terling, these distinctive features stand out; the simplest means are selected, the devices nearest to hand adopted, but the whole procedure is directed to solving, as accurately as the conditions of the work will allow, the problem in view.

The four splendid volumes recently issued by the Cambridge University Press are a striking monument of his ability; these, with the "Theory of Sound," contain his contributions to the advancement of natural knowledge, and with their help it becomes possible to give some idea of his work.

Born on November 12, 1842, the son of the second Lord Rayleigh, he was educated at Trinity College, Cambridge, which he entered in October, 1861.

Some three years later, January, 1865, he took his degree as senior wrangler. In 1866 he was elected to a fellowship, which he held until his marriage in 1871.

The first paper in his collected works is dated 1869. His latest contribution to science was read before the Mathematical Society in June of the present year, and deals with Poisson's solution of the differential equation of wave motion.

The earlier papers are miscellaneous in character. One of the most important, on the theory of resonance (*Phil. Trans.*, 1870), appears again in an altered form as an important section of the "Theory of Sound," while a series of optical papers in the *Philosophical Magazine* for 1871, dealing with the colour of the sky, the scattering of light by small particles, double refraction, and the reflection of light from transparent matter, have long been classical.

In the first of these he proved that the intensity of the light reflected from small particles varies inversely as the fourth power of the wave-length; the third paper discusses the properties of an incompressible æolotropic ether, in which the inertia is a function of the direction, while the forces are the same as those in an isotropic medium; it appears that in such an ether the wave surface would not be that of Fresnel; it has since been shown that if the medium be not incompressible, but be such that the forces resisting compression are zero, then the wave surface is Fresnel's, but the motion is no longer in the wave front. The fourth paper of this series puts in a clear and definite manner the strict theory of reflection of waves in an elastic solid as developed by Green, distinguishing clearly between his results and those of other writers less rigid in their demonstrations.

Another series of optical papers of great importance was published in the *Philosophical Magazine* nine years later, in 1880.

These dealt with the theory of certain optical instruments, especially with regard to their separating or resolving power. In the first of these is established the fundamental law that a double line, when viewed through a telescope, cannot be fairly resolved unless its components subtend an angle exceeding that subtended by the wave-length of light at a distance equal to the horizontal aperture, and the principles leading to this law, applicable to a telescope, have been extended to the case of a microscope in more recent papers published in the *Philosophical Magazine* in 1896, and in the *Journal* of the Royal Microscopical Society, 1903.

Lord Rayleigh's contributions to optics are, however, best summed up in his article on wave theory in the ninth edition of the "Encyclopædia Britannica," and in themselves constitute a claim to the highest distinction.

Clerk Maxwell died in the autumn of 1879, and Lord Rayleigh, in response to an influential memorial, expressed his willingness to carry on the work at the Cavendish Laboratory. He was of course elected, and for the next five years devoted himself to the duties of the chair. The collected papers show us how fruitful those years were; moreover, in addition to original research, there was much to be done in organising the teaching and practical work in the laboratory. On his appointment pupils were few, and organised instruction hardly existed. Maxwell had collected a number of graduate students and inspired them with a keen love for research and investigation, but the practical classes which in Lord Rayleigh's time became so prominent a feature of the laboratory had almost to be formed. In 1879 the natural science tripos contained twenty-five names; in 1884 there were eighty successful candidates, very many of whom obtained a large portion of their training at the laboratory.

The researches of this period include the well known series of investigations into the fundamental electrical units. These were determined with an accuracy which it is difficult even after twenty years' experience of similar measurements to surpass, and have formed the foundation for the legal standards of resistance, current, and electromotive force throughout the world.

Allusion should be made to a short paper in the *Philosophical Magazine* for 1892 on a comparison of the methods for the determination of resistance in absolute

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measure, which, as a recent writer in these columns, in reviewing the collected papers, July 30, 1903, observed, "exhibits in a marked degree Lord Rayleigh's great capacity for seeing distinctly the essential point of an experiment or a measurement and keeping that clearly in view throughout. This indeed is a distinguishing feature of his experimental work, a main factor in his success. Those who knew the Cavendish Laboratory when the electrical measurements were going on, or have since visited the laboratory at Terling, from which no less important work is continually being published, have sometimes been astonished at the makeshift character of much of the apparatus. Contrivances of wood and wire and wax do duty where most men would use apparatus elaborated with a quite unnecessary care; but in Lord Rayleigh's case, while the essential instrument on which the accuracy of the investigation really depends is as perfect as the skill of the workman can make it, and in addition has been thought out in all its details so as to fit it best for the purpose immediately in view, for the rest the arrangement which comes first to hand is utilised without regard to appearances."

The Cambridge period came to an end in 1884, but previously to this, in his address as president of the mathematical and physical section of the British Association in 1882, Lord Rayleigh had indicated what the next series of experiments were to be. He referred on that occasion to the supposed relation between the atomic weights of the chemical elements as a subject inviting investigation, and continued, "The time has perhaps come when a redetermination of the densities of the principal gases may be desirable—an undertaking for which I have made some preparations." Two years later, when president of the association at Montreal, speaking of the value of the study of electrolysis as affording a deeper insight into the nature of chemical reaction, he remarked, "And if I might without presumption venture a word of recommendation it would be in favour of a more minute study of the simpler chemical phenomena."

From this time forward Lord Rayleigh has devoted much of his time to the work thus indicated, publishing papers in 1887 and 1889 respectively on the relative densities of hydrogen and oxygen and on the composition of water in which results are given bearing on Prout's hypothesis.

The first article in the fourth volume of the collected papers is a letter to this Journal, which begins:—"I am much puzzled by some recent results as to the density of nitrogen, and shall be much obliged if any of your chemical readers can offer suggestions as to the cause. According to two methods of preparation I obtain quite distinct values. The relative difference, amounting to about 1/1000 part, is small in itself"—the difference ultimately found was 1/200—"but it lies entirely outside the errors of experiment, and can only be attributed to a variation in the character of the gas"; and his paper concludes, "Is it possible that the difference is independent of impurity, the nitrogen being in a different (dissociated) state?" This, which was published in 1892, was the first indication of the discovery of argon.

In the following year, 1893, Lord Rayleigh communicated to the Royal Society a paper on the densities of the principal gases, containing absolute determinations with all the precautions that recent physical experience or theory could suggest. Here again he points out that nitrogen prepared from ammonia is lighter than atmospheric nitrogen by something of the order of one-half per cent.; he excludes the possibility of contamination by any known substance, which suggests, as before, that an explanation is to be looked for in a dissociated state of the nitrogen itself. In April, 1894, he returned to the problem by way of further assuring himself by experiments on actual measured contamination of the absence of known impurities, and as against the dissociation hypothesis ascertained that keeping the lighter nitrogen for eight months did not increase its density. Chemical nitrogen was shown to differ from atmospheric nitrogen. As it appeared that the impurity could not be removed by known processes, and could hardly be in the chemical nitrogen, the next step was to remove the nitrogen from the atmospheric gas. This was essayed by Lord Rayleigh by combination of the nitrogen through the agency of the electric discharge, and by Sir William Ramsay, who had become associated in the work, by passing it over heated magnesium. Both workers were able to announce to the British Association at Oxford the discovery of a residue constituting a new gaseous constituent of atmospheric air. Then followed the joint memoir of Rayleigh and Ramsay on the isolation and properties of argon.

This physico-chemical work has been since continued in various forms, the physical properties of argon and of other gases have been investigated, and in particular attention has been given to the accuracy with which Boyle's law is satisfied at the ordinary temperature. This investigation has been extended from pressures of 0·01 mm. of mercury up to 150 mm., and the research is still in progress.

In addition to this physical work, numerous mathematical papers, chiefly on problems relating to wave motion and vibrations, should be mentioned.

Meanwhile, wide as has been the field of pure science covered by Lord Rayleigh's activities, he has found time to spare for the promotion of the application of science to industry and commerce. He was a prominent member of the Board of Trade Committee on Electrical Standards, to which we owe the legal definitions of the ohm, the ampere, and the volt. He presided over the Treasury Committee which recommended the establishment of the National Physical Laboratory, and for the past five years has been chairman of the executive committee of the laboratory. To his wise counsels and guidance much of its success is due. Recently he has been a member of a Board of Trade Committee on methods of testing gas, while

he is chairman of the Ordnance Committee of the War Office.

For some time he held the distinguished position of one of the secretaries of the Royal Society.

Throughout his life the search of truth in nature has been his main endeavour.

"The works of the Lord are great
Sought out of all them that have pleasure therein"

is the motto he has prefixed to his collected papers. His friends and pupils throughout the world hope that for many years to come he may continue as their guide in that search which he has already made so fruitful.

PHYSIQUE AND EDUCATION.

Physical Deterioration, its Causes and the Cure. By A. Watt Smyth. Pp. xv+318. (London: John Murray, 1904.) Price 6s. net.

Les Exercises physiques et le Développement intellectuel. By Angelo Mosso. Pp. 294. (Paris: Félix Alcan, 1904.) Price 6 francs.

MRS. WATT SMYTH'S book performs good service in directing the attention of that larger public who imagine Blue-books to be dull, and who avoid the study of health reports, to the national health. Those great weaknesses and injuries that beset the infant citizen have hitherto caused quite insufficient concern. Most of the drawbacks to healthy living here set out were proclaimed by the International Congress of Hygiene in 1891; so slow has been the progress in remedying them that we must hope these chapters will be more widely read than those transactions have been. Evidently many good sources of evidence have been carefully searched; even the sociologist may seek here for references, and while the frequent change of theme has necessitated brevity, the most salient facts and features receive due prominence.

So manifest and so important is the prevalence of physical unfitness in children, as observed first by Dr. Francis Warner, as recently reported on by a Royal Commission (making a striking contrast between the children of Aberdeen and those of Edinburgh), and as now under consideration by a Departmental Committee, that the causes and cure thereof call for this volume, whether or no a "general deterioration" be proved. The argument that excessive urban infant death rate is evidence of deterioration of survivors when illustrated by the annual mortality table of the whole of England (where up to the last decennium such mortality has declined) is an argument against so many individuals deteriorating as formerly. So "Individual Physical Deterioration" would seem a more appropriate title for this work. In any case, the comparison of the present day low expectation of life at Southwark (thirty-six years) with Hampstead (fifty years) is far more important than the consideration of the wretchedness of sixty years ago, when Whitechapel had an expectation of only thirty-one years.

Here are well told the many wants on which unfitness depends. First, in the mother, want of knowledge and want of means; in the infant, want of natural or of proper food; in the pupil, want of sufficient food. Next comes want of air, overcrowding (insufficiently defined), want of school and bedroom ventilation. Further, rest is wanting to the mother, and still more wanting to those children who labour; recreation is wanting to the children, and in the long unbroken hours of school work. Exercise is needed along with recreation.

Such are the causes of physical unfitness; cure lies in their removal. In general, two means of remedy are proposed—legislative measures and increase of instruction and knowledge. Perhaps the legislative proposals of the book evince warm-hearted suggestion rather than practical statesmanship; if there be not in these measures danger of relieving parents of their responsibility, one may yet say with Dr. Bulstrode, the State cannot move except in response to a decisively expressed public opinion, and to load the machinery of public health administration with unpopular measures is, as has been amply exemplified in the history of public health, a futile and eminently unscientific proceeding. To take a current instance; existing powers of making and enforcing by-laws on the overcrowding in the east of London are not carried out, and have not been thoroughly tried.

We welcome in this book a beginning of the other means of remedy—increased knowledge and instruction. A spread of the information here given may render possible in future legislative measures for which the nation is not yet ripe.

We agree with the writer that "the root of the national unfitness lies in the health of the mother during pregnancy and the feeding of infants during their earliest years"; and we read, "out of the children (Sheffield) under two years who had died during the summer of diarrhœa, death in 21 per cent. resulted from the inexperience or ignorance of the mothers."

The better health and physical development (and lower infantile death rate) of Jewish children Dr. Hall "attributes mainly to the fact that Jewish women are better nourished during pregnancy, are more anxious to suckle their children, are more attentive to them in early childhood and feed them with more intelligence." The Royal Commission on Alien Immigration was similarly told, "the difference in the death rate is due to the better care the inhabitants take of themselves and their mode of life," and an appendix shows death rate of infants, Whitechapel 144, Limehouse 204, Whitechapel having nearly double the overcrowding, but 31 per cent. aliens as compared to 3 per cent. in the Limehouse population. Further, while for ten years the aliens and overcrowding had been increasing in Whitechapel, infant deaths had fallen 15 per cent. In Limehouse, with no such increases, deaths had risen 7 per cent. The explanation of these striking figures lies in the fact that the overcrowding of Whitechapel is caused by aliens—for the most part Jews. No laws will remedy ignorance; let us first take the mote out of our own eye and learn a lesson from the Jewess.

Mrs. Watt Smyth has convinced us that the teaching of girls is the key of the position, and her vivid

portrayal of domestic subjects reminds us how peculiarly they are a woman's province.

If all elder girls are taught that the air, food, clothing, washing, rest, and exercise of a baby must, to ensure its health, conform to lessons of experience, if this teaching be based upon reasoned explanations, not only will babies benefit, but young mothers will not discontinue to use their reasoning for the wants of the growing child.

The more liberal views recently adopted by the Board of Education should expedite this reform.

Boys would welcome any teaching that explained how they can best gain and keep strength, and if incidentally they are taught that the habit of drinking more than a pint of beer a day may entail a penalty on health, even if a long-deferred penalty, they will have learnt a fact not one working man in twenty is conscious of to-day. The recent actuarial evidence of the United Kingdom Provident Institution proves that the duration of an abstainer's life, age thirty, is 11 per cent. longer than that of the ordinary temperate insurer.

Teaching will also probably do more for a pure milk supply and for the benefit of a rural population than legislation. Neglect of all subjects bearing on rural occupation in rural school teaching is in itself a lesson to the rustic to ignore such study. How many farmers have heard of cooperative credit, or even know the meaning of the word tuberculosis?

It is pleasant to read how some attempts at amelioration are commencing in the vivid descriptions of the teaching of domestic subjects, the out of school recreation classes, the different systems of physical education, and the practice of physical culture in elementary schools.

Knowledge of the health of the growing child should, we agree, be gained by genuine and efficient observation; as Dr. Bulstrode writes:—"if an officer were appointed to test sight and hearing, detect deformity and reduce the hours of working of the physically and mentally unfit, the harvest would speedily be so abundant that further action would follow in a similar direction."

It is to be hoped this useful and interesting work may come out in a cheaper form, so that it may instruct a wider circle.

Prof. Mosso has long taught us the principles of physical education in his work upon "Fatigue," and in 1893 he published a brief comparative study of the practices in vogue among Continental nations and in England. The present work extends over a wider field. Its nucleus consists of three lectures, part of a course of lectures upon physical education recently instituted in Turin for teachers of gymnastics; they are "Origines et Decadence de l'Agonistique et de la Gymnastique," "L'Agonistique moderne," "L'Éducation physique dans les Universités," and chapters have been added upon the training in ancient Rome, State control, "pédagogie," on the physique of the scholar, and on women's education in America.

Prof. Mosso is an entertaining writer; he sees equally the picturesque side of physical education whether in the palæstra of ancient Greece or at Wellesley College among American girls. In many countries has he travelled, made inquiries on the spot and studied their literature. Accordingly, a broad-minded attitude prevails in this book, and the problems of physical education are viewed from a multiplicity of aspects; but the theme of his title is not systematically developed.

One gathers generally that the early days of Greece and Rome with the American student of to-day represent the best combinations of physique and intellect.

Games in the open air are to be encouraged rather than exercises in a hall; the former will include more moral and intellectual improvement. For these games Prof. Mosso adopts the term "agonistique," which has hitherto been applied to the rivalry of athletic sports rather than to the larger congregation who should join in the recreative game. The change of meaning in this hitherto little used word is to be deprecated.

It is pointed out that the word recreation may convey its literal sense if one recognises that those same cells of psychomotor centres which have been engaged in thought and inhibiting motor impulses are re-animated by recreative exercise after study. In devoting themselves to motor activities, the reaction is one that regenerates these nerve cells.

The book affords a pleasant general discussion upon the physical side of education.

Hugh R. Beevor.

FISH-PASSES AND FISH-PONDS.

Fischwege und Fischteiche. Die Arbeiten des Ingenieurs zum nutzen der Fischerei. By Paul Gerhardt. Pp. 147; 142 woodcuts in text. (Leipzig: Wilhelm Engelmann; London: Williams and Norgate, 1904.) Price 5s. net.

It is a strange thing that in the articles upon river engineering in the latest edition of the "Encyclopædia Britannica" there is no reference to the construction of fish ladders, nor is there, we believe, any comprehensive work upon this subject which has been produced in Britain. The present work is intended primarily for the purpose of instructing engineers in that branch of fresh-water engineering which concerns fishery matters.

The author rightly insists upon the necessity of engineers who propose to undertake the planning and building of fish passes or ponds knowing the habits of the fishes concerned, and in his "Einleitung" of nineteen pages sets out concisely the necessary information in this direction. His statements in some cases, however, for example with regard to the habits of the salmon in the sea and in the river, appear to us somewhat too "cut and dried" considering the speculative condition of our knowledge upon the subject.

The second part of the book deals with fishways, and after a general dissertation upon their importance

the various forms of fish pass are considered the pool fishway, the oblique pass, queen's gap, and the various forms of fish ladders. The various forms are described, but are quite insufficiently criticised. The oblique groove, "Schrägpasse" (under which, by the way, is included the queen's gap pass, "Wehreinschnitt") is dealt with at some length, although it, *i.e.* the oblique groove, was years ago considered utterly useless in Britain, where it was chiefly tried.

The information upon fish ladders is arranged under headings "Fischtreppen mit Stegen," "Fischtreppen mit Sperren u. Einschnitten," and "Lachstreppen mit Sperren u. Schlupfoffnungen," no distinction being drawn between step fishways and inclined fishways, although, in Britain and America at any rate, the latter form has been considered vastly superior to the former.

Seeing that the author in his preface undertakes the consideration of foreign fishways as well as of German ones, we should have expected to see more fish ladders described and discussed, especially those of this country and America, where this branch of engineering has had plenty of scope. The "Smith's Ladder" at the lower falls on the Ballysadare River is described and figured, but no mention is made of the ladder at the Collooney Falls on the same river, which is a combination of Cail's and Smith's inventions. The first Smith's pass, and one of the most successful in Scotland—that at Deanstone, on the Teith—surely deserved mention, as did the inventor. The "queen's gap" at Poolquay Weir, on the Severn, is described in detail, although the weir was washed away in 1881, and has never been rebuilt.

Part iii. is devoted to fish-ponds. There is only one reference to an English fish farm, and none of the numerous American hatcheries, where pond construction has been carefully studied, are mentioned.

Much of this part of the book is of less value from the British fish culturist's or engineer's point of view, because in Germany coarse fish, such as the carp, are a staple food, and are reared in large numbers, whereas most of our fish culture is concerned with the Salmonidæ. As the author says:—

"Der Karpfen ist derjenige Fisch, der sich am besten für die Teichwirtschaft eignet. Er ist ein Edelfisch, leicht zu ziehen und schnellwüchsig, so dass er gute Erträge liefert,"

and this section of the book is written very much from this point of view.

Much of the information as to the construction of ponds and their inlets and outflows is, of course, ancient, and can be found in such books as the "History of Howietoun," by the late Sir R. Gibson-Maitland.

The book is doubtless a useful exposition of some of the existing fish passes and ponds, but in such a work we should have expected to find fuller criticisms and summaries, for instance, as to the value of one form of pass compared with another.

On the whole, we think a more useful book could be written from a British engineer's point of view.

FRANK BALFOUR BROWNE.

OUR BOOK SHELF.

Photographic Chemicals and How to Make Them. By W. Taylor. Pp. 107. (London: Iliffe and Sons, Limited.) Price 1*s*.

This small volume of a hundred pages consists of explanatory remarks on various chemical operations, such as filtering, weighing, boiling, and so on, and concise instructions for the preparation of twenty-one substances that are in common use by photographers. The author considers that "the processes may form a pleasant variation upon ordinary photographic methods." He adds that "it must not be supposed that there will be a saving of cost," but "the pleasure and amusement afforded by the manipulations, to say nothing of their value educationally, if followed out with due care, should do far more than compensate for the trifling increase in expense." The instructions given are clear and correct, and are illustrated by several good figures of really practical apparatus, but, as is often the case in such volumes, the style is uneven. If the book is intended for those who will profit by being told how to test with litmus paper and how to bend a glass tube, and need to have figures to show what kind of things a pestle and mortar, an evaporating dish and a pair of tongs are, then the descriptions of processes are far too lacking in detail. They are more of the character of instructions that might be given to a student of chemistry who has had experience in a well appointed laboratory. We very much doubt whether the author or anyone else has boiled away sulphuric acid "in an empty grate"—of an ordinary room, presumably. The open air is suggested as an alternative place for the performance of this and many other operations which would very speedily render it impossible to live in any room where they were going on. The risk of accidents or desirable precautions might have been set forth a little more prominently in case the volume should fall into the hands of those who know nothing of chemistry. However, there are many young people who have "done" a little chemistry at school, and these will no doubt find it useful. It may be noted that the method described for preparing anhydrous sodium acetate is not efficient; it is necessary to fuse the dried salt.

Dictionnaire des Engrais et des Produits chimiques agricoles. By E. S. Bellenoux. Pp. x + 158. (Paris: Schleicher Frères et Cie., 1904.)

This is meant to be a handy book of reference for the farmer and the agricultural student, in which any material used in agriculture may be looked up and information obtained as to its nature, use, adulteration and the like. The arrangement is alphabetical under such heads as "analysis of the soil," "ash," "nitrogen," "purchase of manures"; the treatment is popular, and though results of experiments are occasionally given, there are no references. The scheme of the book causes a good deal of overlapping, and we doubt if the same end of easy reference would not be better attained by a good index to an ordinary book covering the same ground. The information provided is not very well selected nor always correct; for example, we read, "le sulfate d'ammoniaque a, au contraire, la propriété de remonter des profondeurs du sol où l'eau peut l'avoir entrainé et de revenir à la surface: c'est un sel *grimpant*, ainsi qu'on l'a dénommé, et c'est cette propriété spéciale qui le fait employer avant l'hiver afin que les pluies le fassent pénétrer jusqu'aux racines. Si on l'emploie au printemps, il faut l'enfouir par un labour et ne jamais le répandre en couverture. . . . L'azote du sulfate d'ammoniaque est directement assimilable par les plantes."

Actualités scientifiques. By Max de Nansouty. Pp. 329. (Paris: Schleicher Frères et Cie., 1904.) Price 3.50 francs.

THIS collection of short popular essays on scientific subjects is likely to appeal to a wide circle of readers. The questions selected for treatment are those pertaining to recent discoveries which have been given prominence in the Press. To name a few of the titles is enough to show the character of the book, especially when it is added that a subject is rarely given more than four pages by way of explanation:—Radium and radio-activity, wireless telegraphy, captive balloons, electric cookery, and so on. The book may prove of service in this country to young people fond of science who are learning French.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications.*]

An Optical Phenomenon.

A SHORT time ago, when experimenting with a cubical mirror, I noticed the following peculiar phenomenon:—

Diffused daylight from a near window fell on the mirror, and was reflected towards the observer. Now, the mirror was made to revolve slowly. A succession of flashes of white light was thrown at the observer as the different faces passed before the eye. When the rate of about two revolutions per second was reached, instead of the white flashes, a display of various colours, resembling interference colours, was observed, and this effect continued until about six revolutions per second were made, when the colours disappeared, and a uniform grey light was reflected. The experiment was repeatedly made, and always with the same effect.

The exact moment of appearance and disappearance of the colour effect could only be determined approximately, nor is there, apparently, a definite order in which the colours succeed each other. At least, I was unable to distinguish a strict order, but this may have been due to the imperfect way of turning the mirror, viz., by hand power, means of obtaining an absolutely uniform rate not being available. As a rule, several colours appear at the same time, one near the other. On the whole, however, it may be said that green tints predominate, whilst yellow hardly appears. Bluish tints seem to predominate at the beginning and towards the end of the colour range.

The experiment may also be varied in the following manner:—Place the mirror so that the direct sunlight strikes it. Then turning the mirror, observe the path of reflected light on the wall. In this path, not far from the mirror, fasten a piece of white paper to the wall. When the mirror is then turned at the above-named rate, the colours will be seen on the paper.

To secure a quick perception of the colours, it is well, in both cases, to start with a high speed of rotation, and then to slacken it gradually.

I would like to know whether this phenomenon has already been observed by others, and also how it may be explained. FRED J. HILLIG.

St. John's College, Toledo, Ohio, U.S.A.

The Celtic Pony.

AT a sale of Icelandic and Welsh ponies held at Gateshead on July 14, I observed a small black Welsh stallion which had the essential characteristics of the Celtic pony (*Equus caballus celticus*) lately described by Prof. Ewart. There was no trace of a callosity on either hind leg, and the tail had a very well marked caudal fringe or tail-lock, while in most other respects this pony conformed to the Celtic type. I believe that this is the first instance on record of a Welsh pony resembling the Celtic variety in all the main points. The other Welsh ponies at the sale, so far as I noticed, possessed hock callosities, but the majority of these resembled the Celtic pony in having a more or less distinct caudal fringe.

The occurrence of "Celtic" characters in Welsh and other ponies which usually differ from *E. caballus celticus*, as pointed out by Mr. Annandale and myself in a paper on Færöe and Icelandic ponies (*Proc.* Camb. Phil. Soc., vol. xii., 1904), is in no way inconsistent with the view we put forward that the present distribution of the Celtic pony is related to the Viking migration. This view receives confirmation in Dr. Stejneger's statement that there is a Norwegian breed called the "fjordhest" which is closely allied to if not identical with the Celtic pony. But though the purest representatives of the Celtic pony at the present day seem to be generally restricted to certain (usually isolated) parts of north-west Europe, it would appear that there are traces elsewhere of the primitive small-headed horse (the probable ancestor of the Celtic pony, according to Prof. Ewart) which had a wider distribution. The Welsh and other ponies which sometimes show Celtic characters, as well as certain of the smaller Arabs, probably represent such traces (see Ewart, "The Multiple Origin of Horses and Ponies," *Trans.* Highland and Agric. Society of Scotland, 1904).

Out of sixty Icelandic ponies which I examined at the Gateshead sale, I found fourteen without hock callosities, a rather unusually high proportion. All colours were represented, but the commonest and probably the most typical colour with the Icelandic ponies was light dun with a dark line down the centre of the back.

FRANCIS H. A. MARSHALL.

Monksfield, Freshwater Bay, Isle of Wight, August 10.

THE NEEDS OF ANTHROPOLOGY AT CAMBRIDGE.

AT first sight it does not strike one as a particularly edifying spectacle to see an appeal for funds made by a department of an ancient university, but after all it is a hopeful sign, as it indicates normal expansion or growth along new lines. It is a common mistake to regard the Universities of Oxford and Cambridge as well endowed; the wealth, such as it is—or rather such as it was—belongs to the colleges and not to the university, and as these universities are not endowed with public funds, they have to rely solely upon ancient and recent benefactions in addition to fees received from students. Consequently, when old subjects expand rapidly, or new subjects arise, there are insufficient funds to meet their needs; especially is this the case for scientific subjects, as, in addition to the lecturers, class-rooms, and books of the older subjects, these require demonstrators, laboratories, apparatus, and specimens. Museums, which are a necessity to many branches of science, are expensive institutions to erect, maintain, and increase. They are a relatively new feature in university education, and, though they are at present regarded by some with suspicion and by more with dismay, they are essential alike to teaching and research, and it is safe to predict that their value will become increasingly recognised. The chief reasons why museums are so generally misunderstood are because they are too small or too badly constructed to display their contents; they are understaffed and starved in funds for cases and additions, and, finally, they are not properly arranged. The last count is very largely dependent upon the previous conditions, for only those who have had experience can fully realise the impossibility of orderly and educative installation when every department of the museum is overcrowded and new specimens or collections are continually coming in. It is usually extremely difficult for a curator to keep pace with the new material in addition to the ordinary routine work of a museum, and as scarcely any museum has any-

thing like an adequate staff, it is inevitable that something must be left undone. It is certainly the first duty of a curator to take care of his specimens, and thus it naturally happens that what is left to a more convenient season is the educational arrangement and descriptive labelling of the specimens; as it is these deficiencies that cause museums to be condemned as uninteresting or uninstructive, so it is difficult to get out of that vicious circle which is so well described by the proverb, "the destruction of the poor is their poverty."

A circular, signed by the Disney professor of archæology and the curator of the Museum of Archæology and Ethnology at Cambridge, has been issued directing attention to the congested state of the museum and the inability even to store the existing specimens; the nineteenth annual report of the antiquarian committee, which accompanies the appeal, gives a long list of additions to the museum for the year 1903, which proves that it is rapidly and symmetrically growing. Valuable collections have to be stored out of sight, and so are unavailable for purposes of study. The university has assigned a fine site for the proposed new museum, but as the subscriptions hitherto raised only amount to about 3300*l.*, no steps can be taken towards erecting the building.

Not only do the collections require space and cases for them to be seen by the public, and to enable them to be used for purposes of instruction and research, but rooms are required for the teaching staff, and where research and demonstrations can be carried on. The present teaching staff, of subjects connected with the museum, consists of one professor and a lecturer, both with absurdly small stipends. The circular estimates that for the proper development of the department a new museum must be provided, at a cost of 25,000*l.*, in addition to an adequate annual income for maintenance and for the increase of the stipends of the curatorial and teaching staff.

The circular concludes by pointing out that no better centre than the University of Cambridge can be found for the study of anthropology or for the development of a museum of the best kind; many of her students are led for purposes of research, or in the discharge of professional duties, or for pleasure, to divers quarters of the globe, and not a few among these have enriched the museum with valuable collections. The opportunities for the study of primitive society, and for the formation of collections illustrative of its various phases, are rapidly vanishing before the advance of European civilisation. The funds of the university have been strained to their utmost of late years to keep even the older scientific departments abreast of the times. It is therefore necessary to appeal for outside help in order to raise the funds required for the erection, equipment, and endowment of a museum of anthropology which shall be worthy of the university.

BRITISH ASSOCIATION MEETING AT CAMBRIDGE.

In the issues of Nature for July 21 and August 4, articles giving general accounts of the local arrangements and of the main items in the sectional programmes were published. At the time of writing this article the sectional committees had not met, so that the programme of technical papers to be read before the sections cannot be fully announced. The meetings begin to-day, but already the reception room at the Guildhall has been opened, and a very large number of members have applied for reserved seats at the first general meeting, when the president will deliver his address. An exceptionally large number of tickets have already been sold, so that there is every probability that the Cambridge meeting will see one of the largest attendances the Association has known during recent years. The unusual number of foreign guests who will be present, and the many leading men of science of Great Britain who have accepted invitations will make the meeting a thoroughly representative one in all branches of science. An interesting memento of the meeting is a book of lithographed signatures of the members of the Association who were present at the first meeting in Cambridge in 1833. There are only a few of these books, and they will be on sale in the reception room during the present meeting.

The arrangements of the reception room and general rooms at the Guildhall are very complete, and now that the somewhat unexpected rush at opening is over the attendants will be able to cope easily with the large amount of business that is to be done. A word should be said about the postal arrangements. A temporary post office has been established in the general reception room, where all postal business can be transacted. For the convenience of members a special box has been provided in which notes for members of the Association may be placed unstamped; these will be sorted and delivered with ordinary letters at the post office in the reception room. One of the new features of the general arrangements is the establishment of a Press Bureau. At this office information will be collected from sectional secretaries and will be available for the Press, so that full information can be obtained without the difficulty of finding the sectional secretaries. It is hoped that this arrangement will facilitate reports of sectional and other meetings, and lead to a more satisfactory account of the Association's proceedings in the Press.

A weather forecast will be supplied by Dr. Shaw from the Meteorological Office twice a day during the meeting. This will be posted in the general reception room.

At present we can only give the titles of a few of the papers which have not appeared in earlier articles. In Section A it is expected that there will be a discussion on *n*-rays. Prof. Lummer and probably Prof. Rubens will take part in the discussion of this most debated question. Mr. Burke, who is one of the few Englishmen who have made experiments on these rays, is also expected to contribute to the discussion. Dr. Rotch, the director of the Blue Hill Observatory, is to read a paper on the temperature of air in cyclones and anticyclones as shown by kite-flights at Blue Hill Observatory, U.S.A. Prof. W. Wien will read a paper on experiments to determine whether the ether moves with the earth or not.

In Section A this year is included as a subsection the department of cosmical physics. Under this subsection is the committee appointed by the International Meteorological Committee at Southport in 1903 to combine and discuss meteorological observations from the point of view of their relations with solar physics. The members of this committee who will attend are, so far as is known at present, Sir J. Eliot, Sir Norman Lockyer, M. A. Angot, Prof. Riccò, Prof. Knut Ångstrom, Prof. Birkeland, Dr. W. J. S. Lockyer, Dr. W. N. Shaw, Mr. Axsel S. Steen, and Prof. S. P. Langley.

In Section B twenty-nine papers are to be communicated. Eleven of these papers are by Cambridge chemists, and a most interesting meeting is looked forward to. The greatest interest perhaps centres round the paper by Dr. Lowry on dynamic isomerism, and the discussion of the report to be presented by Mr. H. O. Jones on the stereo-

chemistry of nitrogen. In this discussion it is expected that Prof. Aschan, of Helsingfors, Prof. Pope, Prof. Kipping, and Prof. Wedekind will take part. In connection with this section the apparatus of Messrs. Heycock and Neville will be on view, and in the University Chemical Laboratory Prof. Liveing has set up an echelon spectroscope with which the Zeeman effect and other interesting phenomena in spectroscopy will be exhibited.

In Section I, devoted to physiology, in addition to the communications already announced, Mr. Hankin, pathologist at Agra, will on Saturday morning deliver a lecture on the spread of plague. Thursday afternoon will be devoted to the heart. Communications from Prof. Sherrington and Miss Sowton on the action of chloroform on the heart, from Dr. W. E. Dixon on the action of alcohol on the heart, and from Dr. G. A. Gibson on the disturbance of cardiac rhythm will be made. Tuesday will be devoted to physiological chemistry. Prof. Macallum, of Toronto, will read a paper on the distribution of potassium in animal and vegetable cells, and a communication will be received from Prof. Kossel and Mr. Dakin on protamines and a general discussion on the nature of proteids. On Friday and Saturday afternoons this section will hold no meetings, but the Physiological and Psychological Societies will meet on these days, so that members of the Association who desire can attend these meetings without missing any of the papers communicated to the Association. On Monday afternoon Prof. Schäfer, of Edinburgh, will give an account of methods of artificial respiration with a special view to the restoration of the apparently drowned. This should be a specially interesting demonstration in view of Prof. Schäfer's new method for producing artificial respiration. The rest of Monday afternoon will be devoted to other demonstrations. The physiological laboratory will be open for inspection by members of the Association during the meetings.

In the Cavendish Laboratory an exhibition of apparatus and objects of scientific interest will be open during the session. Of special interest is the exhibition of geometrical models under Section A, and of models made at various schools under the education section. Among the more interesting of the models under Section A may be mentioned a plaster model of the general cubic surface with its twenty-seven lines drawn on it; and a model of Sir Robert Ball's cylindroid. The Cambridge Scientific Instrument Company is exhibiting a collection of scientific instruments, among which an oscillograph will be shown in action at certain times during the session. The Cambridge University Press is exhibiting a large number of books. Mr. C. E. S. Phillips will exhibit a new automatic vacuum pump, and Prof. J. A. Fleming will show an instrument for measuring wave-lengths used in wireless telegraphy.

Dr. W. N. Shaw will show the "microbarograph" which he and Mr. Dines have recently invented. This instrument is for measuring and recording small and rapid variations of atmospheric pressure, while slow changes are allowed to escape. Various forms of self-recording meteorological instruments will be shown by Messrs. Lander and Smith. A temperature recording instrument is set up at the entrance to the Guildhall by the Cambridge Scientific Instrument Company. In addition to the room used for the main part of the exhibition, the Cavendish and other laboratories will be open for inspection during the session, where members can see the ordinary apparatus in use and study the methods of scientific teaching adopted in the university.

INAUGURAL ADDRESS BY THE RIGHT HON. A. J. BALFOUR, D.C.L., LL.D., M.P., F.R.S., CHANCELLOR OF THE UNIVERSITY OF EDINBURGH, PRESIDENT OF THE ASSOCIATION.

Reflections suggested by the New Theory of Matter.

THE meetings of this great Society have for the most part been held in crowded centres of population, where our surroundings never permit us to forget, were such forgetfulness in any case possible, how close is the tie that binds modern science to modern industry, the abstract researches of the student to the labours of the inventor and the mechanic. This, no doubt, is as it should be. The interdependence of theory and practice cannot be ignored without inflicting injury on both; and he is but a poor friend to either who undervalues their mutual cooperation.

Yet, after all, since the British Association exists for the advancement of science, it is well that now and again we should choose our place of gathering in some spot where science rather than its applications, knowledge, not utility, are the ends to which research is primarily directed.

If this be so, surely no happier selection could have been made than the quiet courts of this ancient University. For here, if anywhere, we tread the classic ground of physical discovery. Here, if anywhere, those who hold that physics is the true *Scientia Scientiarum*, the root of all the sciences which deal with inanimate nature, should feel themselves at home. For, unless I am led astray by too partial an affection for my own University, there is nowhere to be found, in any corner of the world, a spot with which have been connected, either by their training in youth, or by the labours of their maturer years, so many men eminent as the originators of new and fruitful physical conceptions. I say nothing of Bacon, the eloquent prophet of a new era; nor of Darwin, the Copernicus of Biology; for my subject to-day is not the contributions of Cambridge to the general growth of scientific knowledge. I am concerned rather with the illustrious line of physicists who have learned or taught within a few hundred yards of this building—a line stretching from Newton in the seventeenth century, through Cavendish in the eighteenth, through Young, Stokes, Maxwell, in the nineteenth, through Kelvin, who embodies an epoch in himself, down to Rayleigh, Larmor, J. J. Thomson, and the scientific school centred in the Cavendish laboratory, whose physical speculations bid fair to render the closing years of the old century and the opening years of the new as notable as the greatest which have preceded them.

Now what is the task which these men, and their illustrious fellow-labourers out of all lands, have set themselves to accomplish? To what end led these "new and fruitful physical conceptions" to which I have just referred? It is often described as the discovery of the "laws connecting phenomena." But this is certainly a misleading, and in my opinion a very inadequate, account of the subject. To begin with, it is not only inconvenient, but confusing, to describe as "phenomena" things which do not appear, which never have appeared, and which never can appear, to beings so poorly provided as ourselves with the apparatus of sense perception. But apart from this, which is a linguistic error too deeply rooted to be easily exterminated, is it not most inaccurate in substance to say that a knowledge of Nature's laws is all we seek when investigating Nature? The physicist looks for something more than what, by any stretch of language, can be described as "co-existences" and "sequences" between so-called "phenomena." He seeks for something deeper than the laws connecting possible objects of experience. His object is physical reality: a reality which may or may not be capable of direct perception; a reality which is in any case independent of it; a reality which constitutes the permanent mechanism of that physical universe with which our immediate empirical connection is so slight and so deceptive. That such a reality exists, though philosophers have doubted, is the unalterable faith of science; and were that faith *per impossibile* to perish under the assaults of critical speculation, science, as men of science usually conceive it, would perish likewise.

If this be so, if one of the tasks of science, and more particularly of physics, is to frame a conception of the physical universe in its inner reality, then any attempt to

compare the different modes in which, at different epochs of scientific development, this intellectual picture has been drawn cannot fail to suggest questions of the deepest interest. True, I am precluded from dealing with such of these questions as are purely philosophical by the character of this occasion; and with such of them as are purely scientific by my own incompetence. But some there may be sufficiently near the dividing line to induce the specialists who rule by right on either side of it to view with forgiving eyes any trespasses into their legitimate domain which I may be tempted, during the next few minutes, to commit.

Let me, then, endeavour to compare the outlines of two such pictures, of which the first may be taken to represent the views prevalent towards the end of the eighteenth century; a little more than a hundred years from the publication of Newton's "Principia," and, roughly speaking, about midway between that epoch-making date and the present moment. I suppose that if at that period the average man of science had been asked to sketch his general conception of the physical universe, he would probably have said that it essentially consisted of various sorts of ponderable matter, scattered in different combinations through space, exhibiting most varied aspects under the influence of chemical affinity and temperature, but through every metamorphosis obedient to the laws of motion, always retaining its mass unchanged, and exercising at all distances a force of attraction on other material masses, according to a simple law. To this ponderable matter he would (in spite of Rumford) have probably added the so-called "imponderable" heat, then often ranked among the elements; together with the two "electrical fluids," and the corpuscular emanations supposed to constitute light.

In the universe as thus conceived, the most important form of action between its constituents was action at a distance; the principle of the conservation of energy was, in any general form, undreamed of; electricity and magnetism, though already the subjects of important investigation, played no great part in the Whole of things; nor was a diffused ether required to complete the machinery of the universe.

Within a few months, however, of the date assigned for these deliverances of our hypothetical physicist came an addition to this general conception of the world, destined profoundly to modify it. About a hundred years ago Young opened, or re-opened, the great controversy which finally established the undulatory theory of light, and with it a belief in an interstellar medium by which undulations could be conveyed. But this discovery involved much more than the substitution of a theory of light which was consistent with the facts for one which was not; since here was the first authentic introduction [1] into the scientific world-picture of a new and prodigious constituent—a constituent which has altered, and is still altering, the whole balance (so to speak) of the composition. Unending space, thinly strewn with suns and satellites, made or in the making, supplied sufficient material for the mechanism of the heavens as conceived by Laplace. Unending space filled with a continuous medium was a very different affair, and gave promise of strange developments. It could not be supposed that the ether, if its reality were once admitted, existed only to convey through interstellar regions the vibrations which happen to stimulate the optic nerve of man. Invented originally to fulfil this function, to this it could never be confined. And accordingly, as everyone now knows, things which, from the point of view of sense perception, are as distinct as light and radiant heat, and things to which sense perception makes no response, like the electric waves of wireless telegraphy,[2] intrinsically differ, not in kind, but in magnitude alone.

This, however, is not all, nor nearly all. If we jump over the century which separates 1804 from 1904, and attempt to give in outline the world-picture as it now presents itself to some leaders of contemporary speculation, we shall find that in the interval it has been modified, not merely by such far-reaching discoveries as the atomic and molecular composition of ordinary matter, the kinetic theory of gases, and the laws of the conservation and dissipation of energy, but by the more and more important part which electricity and the ether occupy in any representation of ultimate physical reality.

Electricity was no more to the natural philosophers in the year 1700 than the hidden cause of an insignificant phenomenon.[1] It was known, and had long been known, that such things as amber and glass could be made to attract light objects brought into their neighbourhood; yet it was about fifty years before the effects of electricity were perceived in the thunderstorm. It was about 100 years before it was detected in the form of a current. It was about 120 years before it was connected with magnetism; about 170 years before it was connected with light and ethereal radiation.

But to-day there are those who regard gross matter, the matter of everyday experience, as the mere appearance of which electricity is the physical basis; who think that the elementary atom of the chemist, itself far beyond the limits of direct perception, is but a connected system of monads or sub-atoms which are not electrified matter, but are electricity itself; that these systems differ in the number of monads which they contain, in their arrangement, and in their motion relative to each other and to the ether; that on these differences, and on these differences alone, depend the various qualities of what have hitherto been regarded as indivisible and elementary atoms; and that while in most cases these atomic systems may maintain their equilibrium for periods which, compared with such astronomical processes as the cooling of a sun, may seem almost eternal, they are not less obedient to the law of change than the everlasting heavens themselves.

But if gross matter be a grouping of atoms, and if atoms be systems of electrical monads, what are these electrical monads? It may be that, as Prof. Larmor has suggested, they are but a modification of the universal ether, a modification roughly comparable to a knot in a medium which is inextensible, incompressible and continuous. But whether this final unification be accepted or not, it is certain that these monads cannot be considered apart from the ether. It is on their interaction with the ether that their qualities depend; and without the ether an electric theory of matter is impossible.

Surely we have here a very extraordinary revolution. Two centuries ago electricity seemed but a scientific toy. It is now thought by many to constitute the reality of which matter is but the sensible expression. It is but a century ago that the title of an ether to a place among the constituents of the universe was authentically established. It seems possible now that it may be the stuff out of which that universe is wholly built. Nor are the collateral inferences associated with this view of the physical world less surprising. It used, for example, to be thought that mass was an original property of matter, neither capable of explanation nor requiring it; in its nature essentially unchangeable, suffering neither augmentation nor diminution under the stress of any forces to which it could be subjected; unalterably attached to, or identified with, each material fragment, howsoever much that fragment might vary in its appearance, its bulk, its chemical or its physical condition.

But if the new theories be accepted these views must be revised. Mass is not only explicable, it is actually explained. So far from being an attribute of matter considered in itself, it is due, as I have said, to the relation between the electrical monads of which matter is composed and the ether in which they are bathed. So far from being unchangeable, it changes, when moving at very high speeds, with every change in its velocity.

Perhaps, however, the most impressive alteration in our picture of the universe required by these new theories is to be sought in a different direction. We have all, I suppose, been interested in the generally accepted views as to the origin and development of suns with their dependent planetary systems; and the gradual dissipation of the energy which during this process of concentration has largely taken the form of light and radiant heat. Follow out the theory to its obvious conclusions, and it becomes plain that the stars now visibly incandescent are those in mid-journey between the nebulæ from which they sprang and the frozen

[1] The hypothesis of an ether was, of course, not new. But before Young and Fresnel it cannot be said to have been established.

[2] First known through the theoretical work of Maxwell and the experiments of Herz.

[1] The modern history of electricity begins with Gilbert, but I have throughout confined my observations to the post-Newtonian period.

darkness to which they are predestined. What, then, are we to think of the invisible multitude of the heavenly bodies in which this process has been already completed? According to the ordinary view, we should suppose them to be in a state where all possibilities of internal movement were exhausted. At the temperature of interstellar space their constituent elements would be solid and inert; chemical action and molecular movement would be alike impossible, and their exhausted energy could obtain no replenishment unless they were suddenly rejuvenated by some celestial collision, or travelled into other regions warmed by newer suns.

This view must, however, be profoundly modified if we accept the electric theory of matter. We can then no longer hold that if the internal energy of a sun were as far as possible converted into heat either by its contraction under the stress of gravitation or by chemical reactions between its elements, or by any other inter-atomic force; and that, were the heat so generated to be dissipated, as in time it must be, through infinite space, its whole energy would be exhausted. On the contrary, the amount thus lost would be absolutely insignificant compared with what remained stored up within the separate atoms. The system in its corporate capacity would become bankrupt—the wealth of its individual constituents would be scarcely diminished. They would lie side by side, without movement, without chemical affinity; yet each one, howsoever inert in its external relations, the theatre of violent motions, and of powerful internal forces.

Or, put the same thought in another form. When the sudden appearance of some new star in the telescopic field gives notice to the astronomer that he, and perhaps, in the whole universe, he alone, is witnessing the conflagration of a world, the tremendous forces by which this far-off tragedy is being accomplished must surely move his awe. Yet not only would the members of each separate atomic system pursue their relative course unchanged, while the atoms themselves were thus riven violently apart in flaming vapour, but the forces by which such a world is shattered are really negligible compared with those by which each atom of it is held together.

In common, therefore, with all other living things, we seem to be practically concerned chiefly with the feebler forces of Nature, and with energy in its least powerful manifestations. Chemical affinity and cohesion are on this theory no more than the slight residual effects of the internal electrical forces which keep the atom in being. Gravitation, though it be the shaping force which concentrates nebulæ into organised systems of suns and satellites, is trifling compared with the attractions and repulsions with which we are familiar between electrically charged bodies; while these again sink into insignificance beside the attractions and repulsions between the electric monads themselves. The irregular molecular movements which constitute heat, on which the very possibility of organic life seems absolutely to hang, and in whose transformations applied science is at present so largely concerned, cannot rival the kinetic energy stored within the molecules themselves. This prodigious mechanism seems outside the range of our immediate interests. We live, so to speak, merely on its fringe. It has for us no promise of utilitarian value. It will not drive our mills; we cannot harness it to our trains. Yet not less on that account does it stir the intellectual imagination. The starry heavens have from time immemorial moved the worship or the wonder of mankind. But if the dust beneath our feet be indeed compounded of innumerable systems, whose elements are ever in the most rapid motion, yet retain through uncounted ages their equilibrium unskaken, we can hardly deny that the marvels we directly see are not more worthy of admiration than those which recent discoveries have enabled us dimly to surmise.

Now, whether the main outlines of the world-picture which I have just imperfectly presented to you be destined to survive, or whether in their turn they are to be obliterated by some new drawing on the scientific palimpsest, all will, I think, admit that so bold an attempt to unify physical nature excites feelings of the most acute intellectual gratification. The satisfaction it gives is almost æsthetic in its intensity and quality. We feel the same sort of pleasurable shock as when from the crest of some melancholy pass we first see far below us the sudden glories of plain, river, and mountain. Whether this vehement sentiment in favour of a simple universe has any theoretical justification I will not venture to pronounce. There is no *a priori* reason that I know of for expecting that the material world should be a modification of a single medium, rather than a composite structure built out of sixty or seventy elementary substances, eternal and eternally different. Why, then, should we feel content with the first hypothesis and not with the second? Yet so it is. Men of science have always been restive under the multiplication of entities. They have eagerly noted any sign that the chemical atom was composite, and that the different chemical elements had a common origin. Nor, for my part, do I think such instincts should be ignored. John Mill, if I rightly remember, was contemptuous of those who saw any difficulty in accepting the doctrine of "action at a distance." So far as observation and experiment can tell us, bodies *do* actually influence each other at a distance. And why should they not? Why seek to go behind experience in obedience to some *a priori* sentiment for which no argument can be adduced? So reasoned Mill, and to his reasoning I have no reply. Nevertheless, we cannot forget that it was to Faraday's obstinate disbelief in "action at a distance" that we owe some of the crucial discoveries on which both our electric industries and the electric theory of matter are ultimately founded; while at this very moment physicists, however baffled in the quest for an explanation of gravity, refuse altogether to content themselves with the belief, so satisfying to Mill, that it is a simple and inexplicable property of masses acting on each other across space.

These obscure intimations about the nature of reality deserve, I think, more attention than has yet been given to them. That they exist is certain; that they modify the indifferent impartiality of pure empiricism can hardly be denied. The common notion that he who would search out the secrets of Nature must humbly wait on experience, obedient to its slightest hint, is but partly true. This may be his ordinary attitude; but now and again it happens that observation and experiment are not treated as guides to be meekly followed, but as witnesses to be broken down in cross-examination. Their plain message is disbelieved, and the investigating judge does not pause until a confession in harmony with his preconceived ideas has, if possible, been wrung from their reluctant evidence.

This proceeding needs neither explanation nor defence in those cases where there is an apparent contradiction between the utterances of experience in different connections. Such contradictions must of course be reconciled, and science cannot rest until the reconciliation is effected. The difficulty really arises when experience apparently says one thing and scientific instinct persists in saying another. Two such cases I have already mentioned; others will easily be found by those who care to seek. What is the origin of this instinct, and what its value; whether it be a mere prejudice to be brushed aside, or a clue which no wise man would disdain to follow, I cannot now discuss. For other questions there are, not new, yet raised in an acute form by these most modern views of matter, on which I would ask your indulgent attention for yet a few moments.

That these new views diverge violently from those suggested by ordinary observation is plain enough. No scientific education is likely to make us, in our unreflective moments, regard the solid earth on which we stand, or the organised bodies with which our terrestrial fate is so intimately bound up, as consisting wholly of electric monads very sparsely scattered through the spaces which these fragments of matter are, by a violent metaphor, described as "occupying." Not less plain is it that an almost equal divergence is to be found between these new theories and that modification of the common-sense view of matter with which science has in the main been content to work.

What was this modification of common sense? It is roughly indicated by an old philosophic distinction drawn between what were called the "primary" and the "secondary" qualities of matter. The primary qualities, such as shape and mass, were supposed to possess an existence quite independent of the observer; and so far the theory agreed with common sense. The secondary qualities, on the other hand, such as warmth and colour, were thought to have no such independent existence, being, indeed, no more than the resultants due to the action of the primary

qualities on our organs of sense-perception; and here, no doubt, common sense and theory parted company.

You need not fear that I am going to drag you into the controversies with which this theory is historically connected. They have left abiding traces on more than one system of philosophy. They are not yet solved. In the course of them the very possibility of an independent physical universe has seemed to melt away under the solvent powers of critical analysis. But with all this I am not now concerned. I do not propose to ask what proof we have that an external world exists, or how, if it does exist, we are able to obtain cognisance of it. These may be questions very proper to be asked by philosophy; but they are not proper questions to be asked by science. For, logically, they are antecedent to science, and we must reject the sceptical answers to both of them before physical science becomes possible at all. My present purpose requires me to do no more than observe that, be this theory of the primary and secondary qualities of matter good or bad, it is the one on which science has in the main proceeded. It was with matter thus conceived that Newton experimented. To it he applied his laws of motion; of it he predicated universal gravitation. Nor was the case greatly altered when science became as much preoccupied with the movements of molecules as it was with those of planets. For molecules and atoms, whatever else might be said of them, were at least pieces of matter, and, like other pieces of matter, possessed those "primary" qualities supposed to be characteristic of all matter, whether found in large masses or in small.

But the electric theory which we have been considering carries us into a new region altogether. It does not confine itself to accounting for the secondary qualities by the primary, or the behaviour of matter in bulk by the behaviour of matter in atoms; it analyses matter, whether molar or molecular, into something which is not matter at all. The atom is now no more than the relatively vast theatre of operations in which minute monads perform their orderly evolutions; while the monads themselves are not regarded as units of matter, but as units of electricity; so that matter is not merely explained, but is explained away.

Now the point to which I desire to direct attention is not to be sought in the great divergence between matter as thus conceived by the physicist and matter as the ordinary man supposes himself to know it, between matter as it is perceived and matter as it really is, but to the fact that the first of these two quite inconsistent views is wholly based on the second.

This is surely something of a paradox. We claim to found all our scientific opinions on experience; and the experience on which we found our theories of the physical universe is our *sense-perception* of that universe. That *is* experience; and in this region of belief there is no other. Yet the conclusions which thus profess to be entirely founded upon experience are to all appearance fundamentally opposed to it; our knowledge of reality is based upon illusion, and the very conceptions we use in describing it to others, or in thinking of it ourselves, are abstracted from anthropomorphic fancies, which science forbids us to believe and Nature compels us to employ.

We here touch the fringe of a series of problems with which inductive logic ought to deal, but which that most unsatisfactory branch of philosophy has systematically ignored. This is no fault of men of science. They are occupied in the task of making discoveries, not in that of analysing the fundamental presuppositions which the very possibility of making discoveries implies. Neither is it the fault of transcendental metaphysicians. Their speculations flourish on a different level of thought; their interest in a philosophy of nature is lukewarm; and howsoever the questions in which they are chiefly concerned be answered, it is by no means certain that the answers will leave the humbler difficulties at which I have hinted either nearer to or further from a solution. But though men of science and idealists stand acquitted, the same can hardly be said of empirical philosophers. So far from solving the problem, they seem scarcely to have understood that there was a problem to be solved. Led astray by a misconception to which I have already referred; believing that science was concerned only with (so-called) "phenomena," that it had done all that it could be asked to do if it accounted for the sequence of our individual sensations, that it was concerned only with the "laws of Nature," and not with the inner character of physical reality; disbelieving, indeed, that any such physical reality does in truth exist;—it has never felt called upon seriously to consider what are the actual methods by which science attains its results, and how those methods are to be justified. If anyone, for example, will take up Mill's logic, with its "sequences and co-existences between phenomena," its "method of difference," its "method of agreement," and the rest; if he will then compare the actual doctrines of science with this version of the mode in which those doctrines have been arrived at,—he will soon be convinced of the exceedingly thin intellectual fare which has been hitherto served out to us under the imposing title of Inductive Theory.

There is an added emphasis given to these reflections by a train of thought which has long interested me, though I acknowledge that it never seems to have interested anyone else. Observe, then, that in order of logic sense-perceptions supply the premisses from which we draw all our knowledge of the physical world. It is they which tell us there *is* a physical world; it is on their authority that we learn its character. But in order of causation they are effects due (in part) to the constitution of our organs of sense. What we see depends not merely on what there is to be seen, but on our eyes. What we hear depends not merely on what there is to hear, but on our ears. Now, eyes and ears, and all the mechanism of perception, have, as we know, been evolved in us and our brute progenitors by the slow operation of Natural Selection. And what is true of sense-perception is of course also true of the intellectual powers which enable us to erect upon the frail and narrow platform which sense-perception provides, the proud fabric of the sciences.

Now Natural Selection only works through utility. It encourages aptitudes useful to their possessor or his species in the struggle for existence, and, for a similar reason, it is apt to discourage useless aptitudes, however interesting they may be from other points of view, because, being useless, they are probably burdensome.

But it is certain that our powers of sense-perception and of calculation were fully developed ages before they were effectively employed in searching out the secrets of physical reality—for our discoveries in this field are the triumphs but of yesterday. The blind forces of Natural Selection, which so admirably simulate design when they are providing for a present need, possess no power of prevision, and could never, except by accident, have endowed mankind, while in the making, with a physiological or mental outfit adapted to the higher physical investigations. So far as natural science can tell us, every quality of sense or intellect which does not help us to fight, to eat, and to bring up children, is but a by-product of the qualities which do. Our organs of sense-perception were not given us for purposes of research; nor was it to aid us in meting out the heavens or dividing the atom that our powers of calculation and analysis were evolved from the rudimentary instincts of the animal.

It is presumably due to these circumstances that the beliefs of all mankind about the material surroundings in which it dwells are not only imperfect but fundamentally wrong. It may seem singular that down to, say, five years ago, our race has, without exception, lived and died in a world of illusions; and that its illusions, or those with which we are here alone concerned, have not been about things remote or abstract, things transcendental or divine, but about what men see and handle, about those "plain matters of fact" among which common sense daily moves with its most confident step and most self-satisfied smile. Presumably, however, this is either because too direct a vision of physical reality was a hindrance, not a help, in the struggle for existence; because falsehood was more useful than truth; or else because with so imperfect a material as living tissue no better results could be attained. But, if this conclusion be accepted, its consequences extend to other organs of knowledge besides those of perception. Not merely the senses, but the intellect, must be judged by it; and it is hard to see why evolution, which has so lamentably failed to produce trustworthy instruments for obtaining the raw material of experience, should be credited with a larger measure of success in its provision of the physiological

arrangements which condition reason in its endeavours to turn experience to account.

Considerations like these, unless I have compressed them beyond the limits of intelligibility, do undoubtedly suggest a certain inevitable incoherence in any general scheme of thought which is built out of materials provided by natural science alone. Extend the boundaries of knowledge as you may; draw how you will the picture of the universe; reduce its infinite variety to the modes of a single space filling ether; retrace its history to the birth of existing atoms; show how under the pressure of gravitation they became concentrated into nebulæ, into suns, and all the host of heaven; how, at least in one small planet, they combined to form organic compounds; how organic compounds became living things; how living things, developing along many different lines, gave birth at last to one superior race; how from this race arose, after many ages, a learned handful, who looked round on the world which thus blindly brought them into being, and judged it, and knew it for what it was:—perform, I say, all this, and, though you may indeed have attained to science, in nowise will you have attained to a self-sufficing system of beliefs. One thing at least will remain, of which this long-drawn sequence of causes and effects gives no satisfying explanation; and that is knowledge itself. Natural science must ever regard knowledge as the product of irrational conditions, for in the last resort it knows no others. It must always regard knowledge as rational, or else science itself disappears. In addition, therefore, to the difficulty of extracting from experience beliefs which experience contradicts, we are confronted with the difficulty of harmonising the pedigree of our beliefs with their title to authority. The more successful we are in explaining their origin, the more doubt we cast on their validity. The more imposing seems the scheme of what we know, the more difficult it is to discover by what ultimate criteria we claim to know it.

Here, however, we touch the frontier beyond which physical science possesses no jurisdiction. If the obscure and difficult region which lies beyond is to be surveyed and made accessible, philosophy, not science, must undertake the task. It is no business of this Society. We meet here to promote the cause of knowledge in one of its great divisions; we shall not help it by confusing the limits which usefully separate one division from another. It may perhaps be thought that I have disregarded my own precept—that I have wilfully overstepped the ample bounds within which the searchers into Nature carry on their labours. If it be so, I can only beg your forgiveness. My first desire has been to rouse in those who, like myself, are no specialists in physics, the same absorbing interest which I feel in what is surely the most far-reaching speculation about the physical universe which has ever claimed experimental support; and if in so doing I have been tempted to hint my own personal opinion that as natural science grows it leans more, not less, upon an idealistic interpretation of the universe, even those who least agree may perhaps be prepared to pardon.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PROF. HORACE LAMB, LL.D., D.SC., F.R.S., PRESIDENT OF THE SECTION.

THE losses sustained by mathematical science in the past twelvemonth have perhaps not been so numerous as in some years, but they include at least one name of world-wide import. Those of us who were students of Mathematics thirty or forty years ago will recall the delight which we felt in reading the geometrical treatises of George Salmon, and the brilliant contrast which they exhibited with most of the current text-books of that time. It was from him that many of us first learned that a great mathematical theory does not consist of a series of detached propositions carefully labelled and arranged like specimens on the shelves of a museum, but that it forms an organic whole, instinct with life, and with unlimited possibilities of future development. As systematic expositions of the actual state of the science, in which enthusiasm for what is new is tempered by a due respect for what is old, and in which new and old are brought into harmonious relation with each other, these treatises stand almost unrivalled. Whether in the originals, or in the guise of translations, they are accounted as classics in every university of the world. So far as British universities are concerned, they have formed the starting-point of a whole series of works conceived in a similar spirit, though naturally not always crowned by the same success. The necessity for this kind of work grows, indeed, continually; the modern fragmentary fashion of original publication and the numerous channels through which it takes place make it difficult for anyone to become initiated into a new scientific theory unless he takes it up at the very beginning and follows it diligently throughout its course, backwards and forwards, over rough ground and smooth. The classical style of memoir, after the manner of Lagrange, or Poisson, or Gauss, complete in itself and deliberately composed like a work of art, is continually becoming rarer. It is, therefore, more and more essential that from time to time some one should come forward to sort out and arrange the accumulated material, rejecting what has proved unimportant, and welding the rest into a connected system. There is perhaps a tendency to assume that such work is of secondary importance, and can be safely left to subordinate hands. But in reality it makes severe demands on even the highest powers; and when these have been available the result has often done more for the progress of science than the composition of a dozen monographs on isolated points. For proof one need only point to the treatises of Salmon himself, or recall (in another field) the debt which we owe to such books as the "Treatise on Natural Philosophy" and the "Theory of Sound," whose authors are happily represented amongst us.

A modest but most valuable worker has passed away in the person of Prof. Allman. His treatise on the history of Greek Geometry, full of learning and sound mathematical perception, is written with great simplicity, and an entire absence of pedantry or dogmatism. It ranks, I believe, with the best that has been done in the subject. It is to be regretted that, as an historian, he leaves so few successors among British mathematicians. We have amongst us, as a result of our system of university education, many men of trained mathematical faculty and of a scholarly turn of mind, with much of the necessary linguistic equipment, who feel, however, no special vocation for the details of recent mathematical research. Might not some of this ability be turned to a field, by no means exhausted, where the severity of mathematical truth is tempered by the human interest attaching to the lives, the vicissitudes, and even the passions and the strife of its devotees, who through many errors and perplexities have contrived to keep alive and trim the sacred flame, and to hand it on burning ever clearer and brighter?

In another province we have to record the loss of Dr. Isaac Roberts, a distinguished example of the class of non-professional investigators who have left so deep a mark on British science and on Astronomy in particular. Few of us can be unaware of his long and enthusiastic devotion to celestial photography, of the beauty and delicacy of the results which he achieved, or of the wealth of unsuspected detail which they brought to light.

Finally, we have to lament the death, within the last few days, of Prof. Everett, whose name will always be associated with one of the most successful tasks which the British Association has taken in hand, viz., the promotion of a uniform system of dynamical and electrical units. He acted as Reporter to the Committee entrusted with the question, and by his handbook on "Units and Physical Constants," he has done more, perhaps, than anyone else to popularise and establish its recommendations. He was well known to most of us as a bright and genial presence at these meetings, and contributed numerous interesting papers on optical and other subjects. He was happy in retaining his scientific faculties undimmed to the last, and was engaged at the time of his death on some problems of a mathematical kind, on point-assemblages, suggested by a study of the recent speculations of Prof. Osborne Reynolds.

Of the various subjects which fall within the scope of this Section there is no difficulty in naming that which at the present time excites the widest interest. The phenomena of Radio-activity, Ionisation of Gases, and so on, are not only startling and sensational in themselves, they

have suggested most wonderful and far-reaching speculations, and, whatever be the future of these particular theories, they are bound in any case deeply to influence our views on fundamental points of chemistry and physics. No reference to this subject would, I think, be satisfactory without a word of homage to the unsurpassed patience and skill in the devising of new experimental methods to meet new and subtle conditions which it has evoked. It will be felt as a matter of legitimate pride by many present that the University of Cambridge has been so conspicuously associated with this work. It would therefore have been natural and appropriate that this Chair should have been occupied, this year above others, by one who could have given us a survey of the facts as they at present stand, and of their bearing, so far as can be discerned, on other and older branches of physics. Whether from the experimental or from the more theoretical and philosophical standpoint, there would have been no difficulty in finding exponents of unrivalled authority. But it has been otherwise ordered, and you and I must make the best of it. If the subject cannot be further dealt with for the moment, we have the satisfaction of knowing that it will in due course engage the attention of the Section, and that we may look forward to interesting and stimulating discussions, in which we trust the many distinguished foreign physicists who honour us by their presence will take an active part.

It is, I believe, not an unknown thing for your President to look up the records of previous meetings in search of inspiration, and possibly of an example. I have myself not had to look very far, for I found that when the British Association last met in Cambridge, in the year 1862, this Section was presided over by Stokes, and, moreover, that the Address which he gave was probably the shortest ever made on such an occasion, for it occupies only half a page of the report, and took, I should say, some three or four minutes to deliver. It would be to the advantage of the business of the meeting, and to my own great relief, if I had the courage to follow so attractive a precedent; but I fear that the tradition which has since established itself is too strong for me to break without presumption. I will turn, therefore, in the first instance, to a theme which, I think, naturally presents itself—viz., a consideration of the place occupied by Stokes in the development of Mathematical Physics. It is not proposed to attempt an examination or appreciation of his own individual achievements; this has lately been done by more than one hand, and in the most authoritative manner. But it is part of the greatness of the man that his work can be reviewed from more than one standpoint. What I specially wish to direct attention to on this occasion is the historical or evolutionary relation in which he stands to predecessors and followers in the above field.

The early years of Stokes's life were the closing years of a mighty generation of mathematicians and mathematical physicists. When he came to manhood, Lagrange, Laplace, Poisson, Fourier, Fresnel, Ampère, had but recently passed away. Cauchy alone of this race of giants was still alive and productive. It is upon these men that we must look as the immediate intellectual ancestors of Stokes, for, although Gauss and F. Neumann were alive and flourishing, the interaction of German and English science was at that time not very great. It is noteworthy, however, that the development of the modern German school of mathematical physics, represented by Helmholtz and Kirchhoff, in linear succession to Neumann, ran in many respects closely parallel to the work of Stokes and his followers.

When the foundations of Analytical Dynamics had been laid by Euler and d'Alembert, the first important application was naturally to the problems of Gravitational Astronomy; this formed, of course, the chief work of Laplace, Lagrange, and others. Afterwards came the theoretical study of Elasticity, Conduction of Heat, Statical Electricity, and Magnetism. The investigations in Elasticity were undertaken mainly in relation to Physical Optics, with the hope of finding a material medium capable of conveying transverse vibrations, and of accounting also for the various phenomena of reflection, refraction, and double refraction. It has often been pointed out, as characteristic of the French school referred to, that their physical speculations were largely influenced by ideas transferred from Astronomy; as, for instance, in the conception of a solid body as made up of discrete particles acting on one another at a distance with forces in the lines joining them, which formed the basis of most of their work on Elasticity and Optics. The difficulty of carrying out these ideas in a logical manner was enormous, and the strict course of mathematical deduction had to be replaced by more or less precarious assumptions. The detailed study of the geometry of a continuous deformable medium which was instituted by Cauchy was a first step towards liberating the theory from arbitrary and unnecessary hypothesis; but it was reserved for Green, the immediate predecessor of Stokes among English mathematicians, to carry out this process completely and independently, with the help of Lagrange's general dynamical methods, which here found their first application to questions of physics outside the ordinary Dynamics of rigid bodies and fluids. The modern school of English physicists, since the time of Green and Stokes, have consistently endeavoured to make out, in any given class of phenomena, how much can be recognised as a manifestation of general dynamical principles, independent of the particular mechanism which may be at work. One of the most striking examples of this was the identification by Maxwell of the laws of Electromagnetism with the dynamical equations of Lagrange. It would, however, be going too far to claim this tendency as the exclusive characteristic of English physicists; for example, the elastic investigations of Green and Stokes have their parallel in the independent though later work of Kirchhoff; and the beautiful theory of dynamical systems with latent motion which we owe to Lord Kelvin stands in a very similar relation to the work of Helmholtz and Hertz.

But perhaps the most important and characteristic feature in the mathematical work of the later school is its increasing relation to and association with experiment. In the days when the chief applications of Mathematics were to the problems of Gravitational Astronomy, the mathematician might well take his materials at second hand; and in some respects the division of labour was, and still may be, of advantage. The same thing holds, in a measure, of the problems of ordinary Dynamics, where some practical knowledge of the subject-matter is within the reach of everyone. But when we pass to the more recondite phenomena of Physical Optics, Acoustics, and Electricity, it hardly needs the demonstrations which have involuntarily been given to show that the theoretical treatment must tend to degenerate into the pursuit of mere academic subtleties unless it is constantly vivified by direct contact with reality. Stokes, at all events, with little guidance or encouragement from his immediate environment, made himself from the first practically acquainted with the subjects he treated. Generations of Cambridge students recall the enthusiasm which characterised his experimental demonstrations in Optics. These appealed to us all; but some of us, I am afraid, under the influence of the academic ideas of the time, thought it a little unnecessary to show practically that the height of the lecture-room could be measured by the barometer, or to verify the calculated period of oscillation of water in a tank by actually timing the waves with the help of the image of a candle-flame reflected at the surface.

The practical character of the mathematical work of Stokes and his followers is shown especially in the constant effort to reduce the solution of a physical problem to a quantitative form. A conspicuous instance is furnished by the labour and skill which he devoted, from this point of view, to the theory of the Bessel's Function, which presents itself so frequently in important questions of Optics, Electricity, and Acoustics, but is so refractory to ordinary methods of treatment. It is now generally accepted that an analytical solution of a physical question, however elegant it may be made to appear by means of a judicious notation, is not complete so long as the results are given merely in terms of functions defined by infinite series or definite integrals, and cannot be exhibited in a numerical or graphical form. This view did not originate, of course, with Stokes; it is clearly indicated, for instance, in the works of Fourier and Poinsot, but no previous writer had, I think, acted upon it so consistently and thoroughly.

We have had so many striking examples of the fruitfulness of the combination of great mathematical and experi-

mental powers that the question may well be raised, whether there is any longer a reason for maintaining in our minds a distinction between mathematical and experimental physics, or at all events whether these should be looked upon as separate provinces which may conveniently be assigned to different sets of labourers. It may be held that the highest physical research will demand in the future the possession of both kinds of faculty. We must be careful, however, how we erect barriers which would exclude a Lagrange on the one side or a Faraday on the other. There are many mansions in the palace of physical science, and work for various types of mind. A zealous, or over-zealous, mathematician might indeed make out something of a case if he were to contend that, after all, the greatest work of such men as Stokes, Kirchhoff, and Maxwell was mathematical rather than experimental in its complexion. An argument which asks us to leave out of account such things as the investigation of Fluorescence, the discovery of Spectrum Analysis, and the measurement of the Viscosity of Gases, may seem audacious; but a survey of the collected works of these writers will show how much, of the very highest quality and import, would remain. However this may be, the essential point, which cannot, I think, be contested, is this, that if these men had been condemned and restricted to a mere book knowledge of the subjects which they have treated with such marvellous analytical ability, the very soul of their work would have been taken away. I have ventured to dwell upon this point because, although I am myself disposed to plead for the continued recognition of mathematical physics as a fairly separate field, I feel strongly that the traditional kind of education given to our professed mathematical students does not tend to its most effectual cultivation. This education is apt to be one-sided, and too much divorced from the study of tangible things. Even the student whose tastes lie mainly in the direction of pure mathematics would profit, I think, by a wider scientific training. A long list of instances might be given to show that the most fruitful ideas in pure mathematics have been suggested by the study of physical problems. In the words of Fourier, who did so much to fulfil his own saying, "L'étude approfondie de la nature est la source la plus féconde des découvertes mathématiques. Non seulement cette étude, en offrant aux recherches un but déterminé, a l'avantage d'exclure les questions vagues et les calculs sans issue; elle est encore un moyen assuré de former l'analyse elle-même, et d'en découvrir les éléments qu'il nous importe le plus de connaître, et que cette science doit toujours conserver: ces éléments fondamentaux sont ceux qui se reproduisent dans tous les effets naturels."

Another characteristic of the applied mathematics of the past century is that it was, on the whole, the age of linear equations. The analytical armoury fashioned by Lagrange, Poisson, Fourier, and others, though subject, of course, to continual improvement and development, has served the turn of a long line of successors. The predominance of linear equations, in most of the physical subjects referred to, rests on the fact that the changes are treated as infinitely small. The electric theory of light forms at present an exception; but even here the linear character of the fundamental electrical relations is itself remarkable, and possibly significant. The theory of small oscillations, in particular, runs as a thread through a great part of the literature of the period in question. It has suggested many important analytical results, and it still gives the best and simplest intuitive foundation for a whole class of theorems which are otherwise hard to comprehend in their various relations, such as Fourier's theorem, Laplace's expansion, Bessel's functions, and the like. Moreover, the interest of the subject, whether mathematical or physical, is not yet exhausted; many important problems in Optics and Acoustics, for example, still await solution. The general theory has in comparatively recent times received an unexpected extension (to the case of "latent motions") at the hands of Lord Kelvin; and Lord Rayleigh, by his continual additions to it, shows that, in his view, it is still incomplete.

When the restriction to infinitely small motions is abandoned, the problems become of course much more arduous. The whole theory, for instance, of the normal modes of vibration which is so important in Acoustics, and even in Music, disappears. The researches hitherto made in this direction have, moreover, encountered difficulties of a less patent character. It is conceivable that the modern analytical methods which have been developed in Astronomy may have an application to these questions. It would appear that there is an opening here for the mathematician; at all events, the numerical or graphical solution of any one of the various problems that could be suggested would be of the highest interest. One problem of the kind is already classical—the theory of steep water-waves discussed by Stokes; but even here the point of view has perhaps been rather artificially restricted. The question proposed by him, the determination of the possible form of waves of permanent type, like the problem of periodic orbits in Astronomy, is very interesting mathematically, and forms a natural starting-point for investigation; but it does not exhaust what is most important for us to know in the matter. Observation may suggest the existence of such waves as a fact; but no reason has been given, so far as I know, why free water-waves should tend to assume a form consistent with permanence, or be influenced in their progress by considerations of geometrical simplicity.

I have tried to indicate the kind of continuity of subject-matter, method, and spirit which runs through the work of the whole school of mathematical physicists of which Stokes may be taken as the representative. It is no less interesting, I think, to examine the points of contrast with more recent tendencies. These relate not so much to subject-matter and method as to the general mental attitude towards the problems of Nature. Mathematical and physical science have become markedly introspective. The investigators of the classical school, as it may perhaps be styled, were animated by a simple and vigorous faith; they sought as a matter of course for a mechanical explanation of phenomena, and had no misgivings as to the trustiness of the analytical weapons which they wielded. But now the physicist and the mathematician alike are in trouble about their souls. We have discussions on the principles of mechanics, on the foundations of geometry, on the logic of the most rudimentary arithmetical processes, as well as of the more artificial operations of the Calculus. These discussions are legitimate and inevitable, and have led to some results which are now widely accepted. Although they were carried on to a great extent independently, the questions involved will, I think, be found to be ultimately very closely connected. Their common nexus is, perhaps, to be traced in the physiological ideas of which Helmholtz was the most conspicuous exponent. To many minds such discussions are repellent, in that they seem to venture on the uncertain ground of philosophy. But, as a matter of fact, the current views on these subjects have been arrived at by men who have gone to work in their own way, often in entire ignorance of what philosophers have thought on such subjects. It may be maintained, indeed, that the mathematician or the physicist, as such, has no special concern with philosophy, any more than the engineer or the geographer. Nor, although this is a matter for their own judgment, would it appear that philosophers have very much to gain by a special study of the methods of mathematical or physical reasoning, since the problems with which they are chiefly concerned are presented to them in a much less artificial form in the circumstances of ordinary life. As regards the present topic I would put the matter in this way, that between Mathematics and Physics on the one hand and Philosophy on the other there lies an undefined borderland, and that the mathematician has been engaged in setting things in order, as he is entitled to do, on his own side of the boundary.

Adopting this point of view, it would be of interest to trace in detail the relationships of the three currents of speculation which have been referred to. At one time, indeed, I was tempted to take this as the subject of my Address; but, although I still think the enterprise a possible one, I have been forced to recognise that it demands a better equipment than I can pretend to. I can only venture to put before you some of my tangled thoughts on the matter, trusting that some future occupant of this Chair may be induced to take up the question and treat it in a more illuminating manner.

If we look back for a moment to the views currently entertained not so very long ago by mathematicians and

physicists, we shall find, I think, that the prevalent conception of the world was that it was constructed on some sort of absolute geometrical plan, and that the changes in it proceeded according to precise laws; that, although the principles of mechanics might be imperfectly stated in our text-books, at all events such principles existed, and were ascertainable, and, when properly formulated, would possess the definiteness and precision which were held to characterise, say, the postulates of Euclid. Some writers have maintained, indeed, that the principles in question were finally laid down by Newton, and have occasionally used language which suggests that any fuller understanding of them was a mere matter of interpretation of the text. But, as Hertz has remarked, most of the great writers on Dynamics betray, involuntarily, a certain *malaise* when explaining the principles, and hurry over this part of their task as quickly as is consistent with dignity. They are not really at their ease until, having established their equations somehow, they can proceed to build securely on these. This has led some people to the view that the laws of Nature are merely a system of differential equations; it may be remarked in passing that this is very much the position in which we actually stand in some of the more recent theories of Electricity. As regards Dynamics, when once the critical movement had set in, it was easy to show that one presentation after another was logically defective and confused; and no satisfactory standpoint was reached until it was recognised that in the classical Dynamics we do not deal immediately with real bodies at all, but with certain conventional and highly idealised representations of them, which we combine according to arbitrary rules, in the hope that if these rules be judiciously framed the varying combinations will image to us what is of most interest in some of the simpler and more important phenomena. The changed point of view is often associated with the publication of Kirchhoff's lectures on Mechanics in 1876, where it is laid down in the opening sentence that the problem of Mechanics is to describe the motions which occur in Nature completely and in the simplest manner. This statement must not be taken too literally; at all events, a fuller, and I think a clearer, account of the province and the method of Abstract Dynamics is given in a review of the second edition of Thomson and Tait, which was one of the last things penned by Maxwell, in 1879 (Nature, vol. xx. p. 213; *Scientific Papers*, vol. ii. p. 776). A "complete" description of even the simplest natural phenomenon is an obvious impossibility; and, were it possible, it would be uninteresting as well as useless, for it would take an incalculable time to peruse. Some process of selection and idealisation is inevitable if we are to gain any intelligent comprehension of events. Thus, in Astronomy we replace a planet by a so-called material particle—*i.e.*, a mathematical point associated with a suitable numerical coefficient. All the properties of the body are here ignored except those of position and mass, in which alone we are at the moment interested. The whole course of physical science and the language in which its results are expressed have been largely determined by the fact that the ideal images of Geometry were already at hand at its service. The ideal representations have the advantage that, unlike the real objects, definite and accurate statements can be made about them. Thus two lines in a geometrical figure can be pronounced to be equal or unequal, and the statement is in either case absolute. It is no doubt hard to divest oneself entirely of the notion conveyed in the Greek phrase ἀεὶ ὁ θεὸς γεωμετρεῖ, that definite geometrical magnitudes and relations are at the back of phenomena. It is recognised indeed that all our measurements are necessarily to some degree uncertain, but this is usually attributed to our own limitations and those of our instruments rather than to the ultimate vagueness of the entity which it is sought to measure. Everyone will grant, however, that the distance between two clouds, for instance, is not a definable magnitude; and the distance of the earth from the sun, and even the length of a wave of light, are in precisely the same case. The notion in question is a convenient fiction, and is a striking testimony to the ascendency which Greek Mathematics have gained over our minds, but I do not think that more can be said for it. It is, at any rate, not verified by the experience of those who actually undertake physical measurements. The more refined the means employed, the more vague and elusive does the supposed magnitude become; the judgment flickers and wavers, until at last in a sort of despair *some* result is put down, not in the belief that it is exact, but with the feeling that it is the best we can make of the matter. A practical measurement is in fact a classification; we assign a magnitude to a certain category, which may be narrowly limited, but which has in any case a certain breadth.

By a frank process of idealisation a logical system of Abstract Dynamics can doubtless be built up, on the lines sketched by Maxwell in the passage referred to. Such difficulties as remain are handed over to Geometry. But we cannot stop in this position; we are constrained to examine the nature and the origin of the conceptions of Geometry itself. By many of us, I imagine, the first suggestion that these conceptions are to be traced to an empirical source was received with something of indignation and scorn; it was an outrage on the science which we had been led to look upon as divine. Most of us have, however, been forced at length to acquiesce in the view that Geometry, like Mechanics, is an applied science; that it gives us merely an ingenious and convenient symbolic representation of the relations of actual bodies; and that, whatever may be the *a priori* forms of intuition, the science as we have it could never have been developed except for the accident (if I may so term it) that we live in a world in which rigid or approximately rigid bodies are conspicuous objects. On this view the most refined geometrical demonstration can be resolved into a series of imagined experiments performed with such bodies, or rather with their conventional representations.

It is to be lamented that one of the most interesting chapters in the history of science is a blank; I mean that which would have unfolded the rise and growth of our system of ideal Geometry. The finished edifice is before us, but the record of the efforts by which the various stones were fitted into their places is hopelessly lost. The few fragments of professed history which we possess were edited long after the achievement.

It is commonly reckoned that the first rude beginnings of Geometry date from the Egyptians. I am inclined to think that in one sense the matter is to be placed much further back, and that the dawn of geometric ideas is to be traced among the prehistoric races who carved rough but thoroughly artistic outlines of animals on their weapons. I do not know whether the matter has attracted serious speculation, but I have myself been led to wonder how men first arrived at the notion of an outline drawing. The primitive sketches referred to immediately convey to the experienced mind the idea of a reindeer or the like; but in reality the representation is purely conventional, and is expressed in a language which has to be learned. For nothing could be more unlike the actual reindeer than the few scratches drawn on the surface of a bone; and it is of course familiar to ourselves that it is only after a time, and by an insensible process of education, that very young children come to understand the meaning of an outline. Whoever he was, the man who first projected the world into two dimensions, and proceeded to fence off that part of it which was reindeer from that which was not, was certainly under the influence of a geometrical idea, and had his feet in the path which was to culminate in the refined idealisations of the Greeks. As to the manner in which these latter were developed, the only indication of tradition is that some propositions were arrived at first in a more empirical or intuitional, and afterwards in a more intellectual way. So long as points had size, lines had breadth, and surfaces thickness, there could be no question of exact relations between the various elements of a figure, any more than is the case with the realities which they represent. But the Greek mind loved definiteness, and discovered that if we agree to speak of lines *as if* they had no breadth, and so on, exact statements became possible. If any one scientific invention can claim pre-eminence over all others, I should be inclined myself to erect a monument to the inventor of the mathematical point, as the supreme type of that process of abstraction which has been a necessary condition of scientific work from the very beginning.

It is possible, however, to uphold the importance of the part which Abstract Geometry has played, and must still play, in the evolution of scientific conceptions, without committing ourselves to a defence, on all points, of the

traditional presentment. The consistency and completeness of the usual system of definitions, axioms, and postulates have often been questioned; and quite recently a more thorough-going analysis of the logical elements of the subject than has ever before been attempted has been made by Hilbert. The matter is a subtle one, and a general agreement on such points is as yet hardly possible. The basis for such an agreement may perhaps ultimately be found in a more explicit recognition of the empirical source of the fundamental conceptions. This would tend, at all events, to mitigate the rigour of the demands which are sometimes made for logical perfection.

Even more important in some respects are the questions which have arisen in connection with the applications of Geometry to purposes of graphical representation. It is not necessary to dwell on the great assistance which this method has rendered in such subjects as Physics and Engineering. The pure mathematician, for his part, will freely testify to the influence which it has exercised in the development of most branches of Analysis; for example, we owe to it all the leading ideas of the Calculus. Modern analysts have discovered, however, that Geometry may be a snare as well as a guide. In the mere act of drawing a curve to represent an analytical function we make unconsciously a host of assumptions which are difficult not merely to prove, but even to formulate precisely. It is now sought to establish the whole fabric of mathematical analysis on a strictly arithmetical basis. To those who were trained in an earlier school, the results so far are in appearance somewhat forbidding. If the shade of one of the great analysts of a century ago could revisit the glimpses of the moon, his feelings would, I think, be akin to those of the traveller to some mediæval town, who finds the buildings he came to see obscured by scaffolding, and is told that the ancient monuments are all in process of repair. It is to be hoped that a good deal of this obstruction is only temporary, that most of the scaffolding will eventually be cleared away, and that the edifices when they reappear will not be entirely transformed, but will still retain something of their historic outlines. It would be contrary to the spirit of this Address to undervalue in any way the critical examination and revision of principles; we must acknowledge that it tends ultimately to simplification, to the clearing up of issues, and the reconciliation of apparent contradictions. But it would be a misfortune if this process were to absorb too large a share of the attention of mathematicians, or were allowed to set too high a standard of logical completeness. In this particular matter of the "arithmetisation of Mathematics" there is, I think, a danger in these respects. As regards the latter point, a traveller who refuses to pass over a bridge until he has personally tested the soundness of every part of it is not likely to go very far; something must be risked, even in Mathematics. It is notorious that even in this realm of "exact" thought discovery has often been in advance of strict logic, as in the theory of imaginaries, for example, and in the whole province of analysis of which Fourier's theorem is the type. And it might even be claimed that the services which Geometry has rendered to other sciences have been almost as great in virtue of the questions which it implicitly begs as of those which it resolves.

I would venture, with some trepidation, to go one step further. Mathematicians love to build on as definite a foundation as possible, and from this point of view the notion of the integral number, on which (we are told) the Mathematics of the future are to be based, is very attractive. But, as an instrument for the study of Nature, is it really more fundamental than the geometrical notions which it is to supersede? The accounts of primitive peoples would seem to show that, in the generality which is a necessary condition for this purpose, it is in no less degree artificial and acquired. Moreover, does not the act of enumeration, as applied to actual things, involve the very same process of selection and idealisation which we have already met with in other cases? As an illustration, suppose we were to try to count the number of drops of water in a cloud. I am not thinking of the mere practical difficulties of enumeration, or even of the more pertinent fact that it is hard to say where the cloud begins or ends. Waiving these points, it is obvious that there must be transitional stages between a more or less dense group of molecules and a drop, and in the case of some of these aggregates it would only be by an arbitrary exercise of judgment that they would be assigned to one category rather than to the other. In whatever form we meet with it, the very notion of counting involves the highly artificial conception of a number of objects which for some purposes are treated as absolutely alike, whilst yet they can be distinguished.

The net result of the preceding survey is that the systems of Geometry, of Mechanics, and even of Arithmetic, on which we base our study of Nature, are all contrivances of the same general kind: they consist of series of abstractions and conventions devised to represent, or rather to symbolise, what is most interesting and most accessible to us in the world of phenomena. And the progress of science consists in a great measure in the improvement, the development, and the simplification of these artificial conceptions, so that their scope may be wider and the representation more complete. The best in this kind are but shadows, but we may continually do something to amend them.

As compared with the older view, the function of physical science is seen to be much more modest than was at one time supposed. We no longer hope by levers and screws to pluck out the heart of the mystery of the universe. But there are compensations. The conception of the physical world as a mechanism, constructed on a rigid mathematical plan, whose most intimate details might possibly some day be guessed, was, I think, somewhat depressing. We have been led to recognise that the formal and mathematical element is of our own introduction; that it is merely the apparatus by which we map out our knowledge, and has no more objective reality than the circles of latitude and longitude on the sun. A distinguished writer not very long ago speculated on the possibility of the scientific mine being worked out within no distant period. Recent discoveries seem to have put back this possibility indefinitely; and the tendency of modern speculation as to the nature of scientific knowledge should be to banish it altogether. The world remains a more wonderful place than ever; we may be sure that it abounds in riches not yet dreamed of; and although we cannot hope ever to explore its innermost recesses, we may be confident that it will supply tasks in abundance for the scientific mind for ages to come.

One significant result of the modern tendency is that we no longer with the same obstinacy demand a mechanical explanation of the phenomena of Light and Electricity, especially since it has been made clear that if one mechanical explanation is possible, there will be an infinity of others. Some minds, indeed, revelling in their new-found freedom, have attempted to disestablish ordinary or "vulgar" matter altogether. I may refer to a certain treatise which, by some accident, does not bear its proper title of "Æther and *no* Matter," and to the elaborate investigations of Prof. Osborne Reynolds, which present the same peculiarity, although the basis is different. Speculations of this nature have, however, been so recently and (if I may say it) so brilliantly dealt with by Prof. Poynting before this Section that there is little excuse for dwelling further on them now. I will only advert to the question whether, as some suggest, physical science should definitely abandon the attempt to construct mechanical theories in the older sense. The question would appear to be very similar to this, whether we should abandon the use of graphical methods in analysis. In either case we run the risk of introducing extraneous elements, possibly of a misleading character; but the gain in vividness of perception and in suggestiveness is so great that we are not likely altogether to forego it, by excess of prudence, in one case more than in the other.

We have travelled some distance from Stokes and the mathematical physics of half a century ago. May I add a few observations which might perhaps have claimed his sympathy? They are in substance anything but new, although I do not find them easy to express. We have most of us frankly adopted the empirical attitude in physical science; it has justified itself abundantly in the past, and has more and more forced itself upon us. We have given up the notion of causation, except as a convenient phrase; what were once called laws of Nature are now simply rules by which we can tell more or less

accurately what will be the consequences of a given state of things. We cannot help asking, How is it that such rules are possible? A rule is invented in the first instance to sum up in a compact form a number of past experiences; but we apply it with little hesitation, and generally with success, to the prediction of new and sometimes strange ones. Thus the law of gravitation indicates the existence of Neptune; and Fresnel's wave-surface gives us the quite unsuspected phenomenon of double refraction. Why does Nature make a point of honouring our cheques in this manner, or, to put the matter in a more dignified form, how comes it that, in the words of Schiller,[1]

> "Mit dem Genius steht die Natur im ewigen Bunde,
> Was der eine verspricht, leistet die andre gewiss"?

The question is as old as science, and the modern tendencies with which we have been occupied have only added point to it. It is plain that physical science has no answer; its policy, indeed, has been to retreat from a territory which it could not securely occupy. We are told in some quarters that it is vain to look for an answer anywhere. But the mind of man is not wholly given over to physical science, and will not be content for ever to leave the question alone. It will persist in its obstinate questionings, and, however hopeless the attempt to unravel the mystery may be deemed, physical science, powerless to assist, has no right to condemn it.

I would like, in conclusion, to read to you a characteristic passage from that Address of Stokes in 1862 which has formed the starting-point of this discourse:—

"In this Section, more, perhaps, than in any other, we have frequently to deal with subjects of a very abstract character, which in many cases can be mastered only by patient study, at leisure, of what has been written. The question may not unnaturally be asked, If investigations of this kind can best be followed by quiet study in one's own room, what is the use of bringing them forward in a Sectional meeting at all? I believe that good may be done by public mention, in a meeting like the present, of even somewhat abstract investigations; but whether good is thus done, or the audience merely wearied to no purpose, depends upon the judiciousness of the person by whom the investigation is brought forward."

It might be urged that these remarks are as pertinent now as they were forty years ago, but I will leave them on their own weighty authority. I will not myself attempt to emphasise them, lest some of my hearers should be tempted to retort that the warning might well be borne in mind, not only in the ordinary proceedings of the Section, but in the composition of a Presidential Address!

SECTION B.

CHEMISTRY.

Opening Address by Prof. Sydney Young, D.Sc., F.R.S., President of the Section.

The researches of Hermann Kopp on the molecular volumes and boiling-points of chemical compounds extended over half a century, beginning with his inaugural dissertation on the densities of oxides in 1838, and concluding in 1889 with a review of the whole of the work done on the subject. In his second paper Kopp considered the molecular volumes of solid compounds, and arrived at the conclusion that truly isomorphous substances have the same atomic or molecular volume, but that in other cases the volumes are usually different. Schröder also made the same observation at about the same time.

Now, isomorphous substances have analogous chemical formulæ, and are usually of similar chemical character, and it is interesting to notice that at this early date the fact was recognised that close chemical relationship is associated with similarity in physical properties.

For about the first six years Kopp was engaged in the consideration of the results obtained by other observers, and from these results he deduced the most important of his generalisations.

As regards boiling-points, Kopp, in 1842, concluded that a constant difference in chemical composition is accompanied by a constant difference in boiling-point, and he adopted the value 18° as the rise due to the replacement of the methyl by the ethyl group in organic compounds, although the observed differences varied between 11°·0 and 24°·8. Two years later he found in sixteen comparisons differences varying from 8° to 33°; but he doubted the correctness of the extreme values, and took 19° as the true value; he further suggested that this is the constant difference for an addition of CH_2 in any homologous series, and he pointed out that the observed difference was most regular in the case of the fatty acids.

Kopp was also of opinion that isomeric compounds with the same composition and the same vapour density have the same boiling-point.

The paucity of experimental data and the wide discrepancies between the results obtained by different observers induced Kopp to undertake the determination of the boiling-points of various compounds, and, later, their molecular volumes at a series of temperatures, and it is interesting to note the comparative crudeness of his first attempts and the increasing attention which he paid to the purification of his compounds and to the elimination of thermometric and other errors. He first examined three pairs of esters in order to find whether isomeric compounds have really the same boiling-points. But he employed only calcium chloride as a dehydrating agent, and this would remove neither water nor the alcohol completely; he was much troubled by the "bumping" of the liquids, and the temperatures he actually observed—with the thermometer bulb in the liquid—fluctuated considerably, and he could only, in most cases, take the lowest temperature observed as the most probable boiling-point. By so doing, and by making a fairly liberal allowance for residual errors, Kopp arrived at the erroneous conclusion that the boiling-points of isomers were the same in the three cases examined, and therefore, probably, in all cases.

The boiling-point of methyl alcohol was of great interest to Kopp, because, taking that of ethyl alcohol—about which there was general agreement—as correct, it should, according to his law, be $78° - 19° = 59°$, while the temperatures actually observed varied from 60° to 66°. Kopp prepared a specimen of methyl alcohol, and found that it boiled at about 65°; but he had more faith in his law than in his experimental result, and he concluded that the methods of determining boiling-points were not sufficiently accurate to give results correct to within even 1° or 2°.

In 1854 he discussed the corrections which should be applied to thermometer readings, giving a table of corrections for the unheated column of mercury, and adopting the value 27 mm. per degree as the value of dp/dt for all substances, in order to reduce the observed boiling-point to that at normal pressure. He pointed out, also, that the height of the barometer should be reduced to 0° C. Taking advantage of Delff's improved method of preparing and purifying methyl alcohol, Kopp made a fresh specimen from methyl oxalate and dried it with lime; but while Delff observed the boiling-point to be 60°, Kopp obtained the value 65°·2 – 65°·8. He was still, however, inclined to think that, owing to bumping, the observed boiling-point was too high and that the true temperature should be about 60°.

Meanwhile, in 1847 Kopp had examined sixteen liquids, including water, two alcohols, three fatty acids, and seven esters, and in 1854, as a result of his further determinations, he was able to compare the boiling-points—and also the molecular volumes—of a large number of substances, most of which were either alcohols, acids, or esters, and he at first adhered to his previous value of 19° for the rise of boiling-point due to the addition of CH_2. Later in the same year, however, taking a wider survey and including hydrocarbons and their halogen derivatives, ethers, sulphides, and other compounds, he was obliged to admit that the difference is in some cases higher, in others lower, than 19°, but he still regarded these cases merely as exceptions to the law. In 1867 Kopp admitted that isomeric aromatic hydrocarbons have not always the same boiling-point, and that the difference for an addition of CH_2 was not always 19°; but he still believed that the difference for CH_2 was constant in any really homologous series—for example, 20°·5 for homologues of toluene, 18°·5 for those of xylene, and 16°·5 for those of trimethylbenzene. He also recognised the fact that isomeric alcohols have widely different boiling-points.

Kopp published no later papers on the boiling-points of

[1] Applied by Herschel to the discovery of Neptune.

organic compounds, although he dealt fully with the question of molecular volumes in his final communication in 1889.

As a pioneer, Kopp had very great difficulties to contend against when he began his researches; data were scanty and far from accurate, and the substances which could be most easily obtained and, it was thought, readily purified were, unfortunately, those which were the least likely to lead to normal generalisations. Water, the alcohols, and the organic acids all contain a hydroxyl group, and we now know that the physical properties of these substances are abnormal in nearly all respects, owing, probably, to the fact that their molecules tend to associate together; moreover, the esters, which are formed by the interaction of acids and alcohols, do not behave quite normally, and there is probably molecular association, though to a much smaller extent than with the hydroxyl compounds.

There can be little doubt that if Kopp had been able, in the first place, to obtain a considerable number of pure substances of normal behaviour, such as the paraffins or their halogen derivatives, he would not have been led to the erroneous conclusions which he defended with such vigour for so many years. If we take the normal paraffins as the simplest class of organic compounds, we find that, instead of the boiling-points rising by equal intervals as the series is ascended, the rise, which is very large for the lowest numbers, becomes smaller and smaller as the molecular weight increases. This fact is, of course, now well known, and various formulæ have been suggested to reproduce these boiling-points. Thus Walker has proposed the formula $T=aM^b$, where T is the boiling-point on the absolute scale of temperature, M is the molecular weight, and a and b are constants. Ramage has this year suggested that this formula applies only to the CH_2 chain linkage, and that the influence of the terminal hydrogen atoms is considerable in the case of the lowest members, but diminishes as the chain lengthens, and becomes eventually either constant or negligible. In other words, the lower members of the series cannot be regarded as truly homologous, and that is a point which is, I think, important to bear in mind. Ramage suggests a new formula, $T=a[M(1-2^{-n})]^{\frac{1}{2}}$, where a is Walker's constant, 37·3775, and n is the number of carbon atoms in the molecule. He assumes, however, a constant difference for CH_2 in the case of the alcohols, the aldehydes, and the ketones, but I doubt whether the boiling-points of the last two classes of compounds are yet sufficiently well established to allow of any certain conclusions being drawn from them.

I am inclined to think that it may be useful to regard the value of Δ (the rise of B.P. for an increment of CH_2) as being mainly a function of the absolute temperature, and I would provisionally suggest the formula $\Delta = \frac{144{\cdot}86}{T^{0{\cdot}0148\sqrt{T}}}$, where Δ is the difference between the boiling-point, T, of any paraffin and that of its next higher homologue. Taking the boiling-point of methane as 106°·75 abs., the values for the higher members agree better with the observed temperatures than those given by Ramage's formula, as will be seen by the first table on the next column.

I do not wish, however, to lay much stress on the actual form of the equation, or on the particular values of the constants; the chief point I wish to direct attention to is that Δ may be regarded as a function of the temperature.

Suppose that we replace a terminal atom of hydrogen in each normal paraffin by chlorine, so as to form the homologous series of primary alkyl chlorides. The boiling-points of these chlorides are much higher, and the differences, Δ, are much smaller than for the corresponding paraffins, but the gradual fall in the values of Δ as the series is ascended is unmistakable. The same remarks apply to the bromides and iodides, the boiling-points being still higher and the values of Δ smaller.

But the point of chief interest appears to me to be this: if the values of Δ for the halogen derivatives are plotted against the absolute temperatures, the points for the most part fall near the curve constructed for the paraffins, and represented by the formula $\Delta = \frac{144{\cdot}86}{T^{0{\cdot}0148\sqrt{T}}}$. The first value of Δ is decidedly low in each case (average deviation from curve 2°·7); the later ones are rather high in nearly every case (average deviation 0°·86). Similar results are in

Paraffin	Boiling-point (abs. temp.)				
	Observed	Calculated. Ramage	Δ	Calculated. Young	Δ
CH_4 ...	108·3	105·7	−2·6	106·75	−1·55
C_2H_6 ...	180·0	177·3	−2·7	177·7	−2·3
C_3H_8 ...	228·0	231·9	+3·9	229·85	+1·85
C_4H_{10} ...	274·0	275·6	+1·6	272·6	−1·4
C_5H_{12} ...	309·3	312·2	+2·9	309·4	+0·1
C_6H_{14} ...	341·95	343·9	+1·95	341·95	0
C_7H_{16} ...	371·4	372·3	+0·9	371·3	−0·1
C_8H_{18} ...	398·6	398·3	−0·3	398·1	−0·5
C_9H_{20} ...	422·5	422·5	0	422·85	+0·35
$C_{10}H_{22}$ ...	446·0	445·2	−0·8	447·85	−0·15
$C_{11}H_{24}$ ...	467·0	466·8	−0·2	467·35	+0·35
$C_{12}H_{26}$ ...	487·5	487·3	−0·2	487·65	+0·15
$C_{13}H_{28}$ ...	507·0	507·0	0	506·8	−0·2
$C_{14}H_{30}$ ...	525·5	526·0	+0·5	525·0	−0·5
$C_{15}H_{32}$ ...	543·5	544·2	+0·7	542·3	−1·2
$C_{16}H_{34}$ ...	560·5	561·9	+1·4	558·85	−1·65
$C_{17}H_{36}$ ...	576·0	579·0	+3·0	574·7	−1·3
$C_{18}H_{38}$ ...	590·0	595·7	+5·7	589·9	−0·1
$C_{19}H_{40}$ ...	603·0	611·9	+8·9	604·5	+1·5

general obtained with other homologous series of compounds in which molecular association is not believed to occur, but, as will be seen from the following table, the deviations from the normal paraffin curve are greater in the case of those series the lower members of which, according to Ramsay and Shields, are characterised by molecular association.

Group	Lower members		Higher members	
	Number of values of Δ	Mean difference calculated − observed	Number of values of Δ	Mean difference calculated − observed
Alkyl chlorides ...	2	+2°·70	5	−1°·04
,, bromides ...	2	+1·12	5	−1·25
,, iodides	2	+0·52	3	−1·0
Isoparaffins	—	—	2	+0·57
Toluene, &c.	1	+0·45	3	+0·68
o-Xylene, &c.	1	+6·1	1	−0·5
m-Xylene, &c. ...	1	+4·25?	1	+4·0?
p-Xylene, &c.	1	−0·15	1	+0·65
Diethylbenzene, &c.	—	—	1	−0·05
Olefines $H_2C=CHR$	—	—	3	−2·35?
,, $RHC=CHR^1$	—	—	3	+0·5?
Polymethylenes ...	—	—	2	−3·85?
Ethers	3	+8·2	13	+1·12
Aldehydes	2	+2·0	4	+1·3
Hydrosulphides ...	2	+3·55	1	−0·5
Amines	2	+8·2	4	+1·7
Esters	47	+4·92	67	+1·53
Associating Substances.				
Cyanides	1	+12°·65	4	+2°·9
Nitromethane, &c. ...	2	+11·1	1	+3·85
Ketones	1	+ 6·2	3	+2·85
Fatty acids	2	+ 5·87	7	+1·58
,, alcohols	2	+12·87	5	+5·24

In the great majority of cases the deviations are greatest for the lowest members of a series, the calculated values of Δ being almost invariably higher than the observed, and this may perhaps be explained in the manner suggested by Ramage. I have, therefore, divided each series into two groups, the first ending and the second beginning with the lowest member of the series which contains a CH_2 group linked to two carbon atoms. Thus, of the alkyl chlorides, the first group contains CH_3Cl, CH_3CH_2Cl, and $CH_3-CH_2-CH_2Cl$, and the second group begins with

propyl chloride, so that all its members contain one or more $C-CH_2-C$ groups.

In the case of the ethers, esters, and other compounds which contain two alkyl radicals, a series is regarded as homologous when one radical remains unaltered and the other increases by stages of CH_2. The variable radical only is considered in dividing the series into the two groups; thus, although propionic acid contains a $C-CH_2-C$ group, it remains unchanged in the propionic esters, the first group of which consists of methyl, ethyl, and propyl propionate, the second beginning with the last-named ester.

Of the seventeen series of non-associating substances there are only five for which the mean difference between the calculated and observed values of Δ for the higher members exceeds 1°·5.

1. The *m*-xylene series. Here there is only one value, which, I think, is doubtful.

2. The olefines, $H_2C=CHR$. Here two of the three individual differences are less than 1°·5; the temperatures are all below 0°, and are somewhat uncertain.

3. The polymethylenes. The difference for pentamethylene and hexamethylene differs by less than 1° from the calculated value. The B.P. of heptamethylene appears very doubtful.

4. The amines. Differences somewhat erratic; three within 1°·5 and two within 0°·5. Octylamine and nonylamine clearly incorrect and not included.

5. The esters. Although Ramsay and Shields include these substances as non-associating, there is, I think, reason to suspect slight association.

It will be seen that the differences are greater for associating than for non-associating substances; also that they are greatest for the alcohols and least for the acids, although the factor of association is very high for both these series. In order to arrive at an explanation of these facts the effect of replacing hydrogen by chlorine may first be considered.

The boiling-point of hydrogen chloride is not yet known accurately, but it must be about −80°. Thus, by replacing an atom of hydrogen in the hydrogen molecule by chlorine the boiling-point is raised from 20°·4 abs. to about 193° abs., or about 173°. On replacing an atom of hydrogen in methane by chlorine the rise of boiling-point is from 108°·3 to 249°·3, or 141°. Ascending the series of paraffins the rise of boiling-point due to the replacement of hydrogen by chlorine diminishes rapidly at first, and then more slowly, being only 58°·5 in the case of octane. Thus the influence of the chlorine atom becomes relatively smaller as the formula weight of the alkyl group increases.

Consider, now, the effect of replacing a hydrogen atom by a hydroxyl group. In the formation of water from hydrogen gas the boiling-point is raised no less than 352°·6, from 20°·4 abs. to 373° abs., or in the ratio of 1 : 18·3; in the case of methane the rise is 221°·8, from 108°·3 to 337°·7, or in the ratio of 1 : 3·12; with octane the rise is 65°·4, from 398°·6 to 464°; and with hexdecane it is only 56°·5, from 560°·5 to 617°, the ratio being 1 : 1·10.

It will be seen that in the case of hydrogen the influence of the hydroxyl is enormously greater, and in the case of methane very much greater, than that of chlorine in raising the boiling-point, but that on ascending the series of paraffins to octane the influence of the hydroxyl group diminishes until it is little greater than that of the chlorine atom, and it is quite probable that with hexdecane it would be somewhat less. This is, no doubt, to be explained by the fact that the molecules of water and of the lower alcohols are highly associated in the liquid, but not in the gaseous state, and therefore, in order to vaporise the liquids, this molecular attraction must be overcome, and the temperature must therefore be raised. The molecular association diminishes, however, as the series of alcohols is ascended, and is probably slight in the case of octyl alcohol. If so, it would appear that the effect of the hydroxyl group—apart from association—in raising the boiling-point is not very different from, and is probably somewhat less than, that of the chlorine atom, and that the difference between the boiling-points of the lower alcohols and of the corresponding chlorides is entirely due to molecular association in the liquid state.

With the acids there is association in the gaseous as well as the liquid state, and since, according to the tables given by Ramsay and Shields, the factor of association for a liquid fatty acid at its boiling-point is rarely greater, and in most cases is somewhat smaller, than for the corresponding liquid alcohol, the molecular attraction to be overcome on vaporisation must be considerably less for the acid than for the corresponding alcohol, and the resulting rise of boiling-point above the normal value must be less. An explanation of the very low values of Δ for the alcohols and the moderately low values for the acids is thus afforded.

It would take up far too much time and space to give full details of the boiling-points of all the compounds considered, with the observed and calculated values of Δ; but it may, I think, be stated that the difference between the boiling-point of any non-associating organic compound which contains at least one $C-CH_2-C$ group, and that of its next higher homologue (at any rate up to temperatures of about 300° C.), may be calculated with an error rarely exceeding 1°·5, and generally under 1°, by means of the formula $\Delta = \frac{144 \cdot 86}{T^{0 \cdot 0148\sqrt{T}}}$. The formula seems also to be applicable to any ester which contains at least five atoms of carbon in the variable alkyl or acyl group (the mean error for 40 values of Δ is +0°·93), and with smaller error when the number of carbon atoms is still larger;[1] it is probably also applicable to the higher fatty acids, cyanides, ketones, and nitro-compounds.

Comparison of Molecular Volumes.

The fundamental idea on which both Kopp and Schröder based their methods of calculating the molecular volumes of organic compounds from the atomic volumes of the component elements was the constancy of the increase in molecular volume for each addition of CH_2. With regard to this point the question was greatly discussed whether the comparison should be made at the same temperature, say 0° C., or at the boiling-points of the compounds under the same pressure. Later, when Van der Waals brought forward his conception of corresponding states, it was thought probable that the comparison should be made at *corresponding* or equal *reduced* temperatures; that is to say, at temperatures which bear the same ratio to the critical temperatures. If the generalisations of Van der Waals were strictly true, the boiling-points under corresponding pressures would be corresponding temperatures, but that is not usually the case. The comparison may, therefore, be made either at equal reduced temperatures or at the boiling-points under equal reduced pressures; or, lastly, it may be made at the critical points themselves, and, thanks to the law of Cailletet and Mathias, the critical volumes can be ascertained with a great degree of accuracy.

In order to find whether the difference in molecular volume for each addition of CH_2 is really constant it is best to examine such perfectly normal substances as the paraffins, and the data for four consecutive members of the series—*n*-pentane, *n*-hexane, *n*-heptane, and *n*-octane—are fortunately available.

In the table below the molecular volumes and the

Paraffin	A		B		C		D		E	
	M. Vol.	Δ	M. Vol.	Δ	M. Vol.	Δ	M. Vol.	Δ	M. Vol.	Δ
n-Pentane ...	111·33		117·80		116·13		116·13		309·3	
		15·44		22·13		20·09		21·66		56·8
n-Hexane ...	126·77		139·93		136·22		137·19		366·1	
		15·69		22·63		20·18		21·49		60·2
n-Heptane ...	142·46		162·56		156·40		158·68		426·3	
		15·88		23·70		20·54		21·83		62·6
n-Octane	158·34		186·26		176·94		180·51		488·9	

[1] Thus the observed B.P. of *n*-hexyl formate is 153°·6, and the value of Δ calculated from the formula is 22·8, giving 176°·4 as the B.P. of the next higher homologue. This agrees very well with the observed B.P. of *n*-heptyl formate, 176°·7, but not with that of *n*-hexyl acetate, 169°·2. Again, the observed B.P. of methyl caproate (hexoate) is 149°·6, and the calculated value of Δ is 23°·0, giving 172°·6 as the B.P. of the next homologue. The observed B.P. of methyl œnanthylate (heptoate) is 172°·1, but that of ethyl caproate is only 166°·6.

differences, Δ, for an addition of CH_2 are given under the following conditions :[1]—

A. At 0° C.

B. At the respective boiling points under 1 atm. pressure.

C. At equal reduced temperatures (0·6396).

D. At the respective boiling-points under equal reduced pressures (0·02241).

E. At the respective critical points.

It will be seen that in every case there is a decided rise in the value of Δ as the series is ascended, but that the rise is relatively smallest when the comparison is made at the particular reduced temperature chosen. At higher reduced temperatures, however, it would be relatively much greater, since it is very marked at the critical point, where the reduced temperature = 1. The rise is also comparatively small at the common temperature 0°, but the comparison would not be satisfactory if a higher common temperature, say 150°, were chosen, because the coefficients of expansion differ considerably; at 150° the values of Δ would be 8·75, 13·45, and 15·38 respectively.

In the case of nine of the lower esters the values of Δ are by no means constant, whether the comparison be made at 0°, at the boiling-point, or at the critical point. The eleven values of Δ vary in the three methods between 16·34 and 18·21, 20·84 and 23·42, 54·3 and 61·7 respectively; but there is not a regular rise with increase of molecular weight.

Both Kopp and Schröder compared the molecular volumes of compounds at their boiling-points under normal pressure, but they deduced quite different values for the atomic volumes of carbon and hydrogen; it is clear, however, that as Δ varies considerably no values whatever for C and H could give accurate results, even in the case of true homologues.

Traube makes the comparison at a common temperature, usually 15°, and takes into consideration both the actual volumes of the molecules and the co-volume, which he assumes to have the same value, 24·5 $(1+at)$, where $a = 1/273$, for all substances. He calculates definite values for the atomic volumes of C and H at a given temperature; thus, at 15°, C = 9·9 and H = 3·1, or $CH_2 = 16·1$, so that here again the difference for CH_2 at a given temperature should be constant.

It does not appear to me that the problem has yet been completely solved, although Traube's method of calculation generally gives much better results than those of Kopp and Schröder.

Comparison of Boiling-points at a Series of Equal Pressures.

The results of this comparison are often exceedingly simple if the two substances compared are very closely related, and if there is no molecular association in either case. Taking, for example, chlorobenzene and bromobenzene, it is found that the ratio of the boiling-points (on the absolute scale of temperature) under equal pressures is constant whatever the pressure may be, or

$$\frac{T_A}{T_B} = \frac{T'_A}{T'_B} = 1·0590.$$

A similar result is obtained with the other halogen derivatives of benzene, with ethyl bromide and ethyl iodide, with ethyl acetate and propyl acetate, and some other pairs of esters; but in some cases of close relationship—for example, with ethyl formate and ethyl acetate—the ratio is not quite constant, and the formula becomes

$$\frac{T_A}{T_B} = \frac{T'_A}{T'_B} + c(T_B - T'_B),$$

where c has a very low value [0·0000417 for these two esters]. When there is no close relationship, but the molecules are not associated, the value of c is usually larger—for example, 0·000185 for carbon disulphide and ethyl bromide.

Lastly, when there is no close relationship and the molecules of one or both substances are associated, the formula

$$\frac{T_A}{T_B} = \frac{T'_A}{T'_B} + c(T_B - T'_B)$$

may no longer hold, and a third term may be required, thus:

$$\frac{T_A}{T_B} = \frac{T'_A}{T'_B} + c(T_B - T'_B) + d(T_B - T'_B)^2;$$

or, in any case, the value of c becomes much higher, as with benzene and ethyl alcohol [c = 0·0008030] or sulphur and carbon disulphide [c = 0·000645].

Behaviour of Liquids when Mixed Together.

There are three points to consider when two liquids are brought together—(1) their miscibility, whether infinite, partial, or inappreciable; (2) the relative volumes of the mixture and of the components; (3) the heat evolved or absorbed.

Liquids which are classed as non-miscible rarely, if ever, bear any close chemical relationship. Thus water is practically non-miscible with all hydrocarbons and with their halogen and many other derivatives; again, mercury, so far as I know, is not miscible with any liquid compound, organic or inorganic. It is true that the higher aliphatic alcohols are almost insoluble in water, although there may be said to be some chemical relationship between them, inasmuch as an alcohol may be regarded as an alkyl derivative of water. But the alcohols may also be looked upon as hydroxyl derivatives of the hydrocarbons, and, the higher the formula weight of the alkyl group, the greater is its influence, relatively to that of the hydroxyl, on the properties of the alcohol. Thus, while the lower alcohols show considerable resemblance to water—for example, in their behaviour with dehydrating agents, such as sodium, phosphoric anhydride, or lime, and in their power of uniting with metallic salts to form crystalline alcoholates corresponding to the hydrates—this resemblance diminishes as we ascend the series, and is generally not observable with the higher members.

On the other hand, the higher the molecular weight of the alcohol the closer is its resemblance to the hydrocarbon from which it is derived. This, as already mentioned, is well shown by the diminishing difference between the boiling-points of the alcohol and paraffin as the series is ascended; it may also be noted that methane was long classed as a permanent gas, while methyl alcohol is a liquid; whereas both hexdecane ($C_{16}H_{34}$) and cetyl alcohol ($C_{16}H_{33}OH$) are solids, the former melting at 18° and the latter at 50°.

It may, in fact, I think, be stated that the chemical relationship between water and methyl alcohol is fairly close, while that between water and cetyl alcohol is very distant. So, also, two adjacent members of a homologous series, such as methyl and ethyl alcohol, are more closely related than two members of widely different molecular weight, such as methyl and cetyl alcohol.

Adopting this view, it is, I believe, safe to state that liquids which are chemically closely related to each other are invariably miscible in all proportions.

As regards the relative volumes of a mixture and of its components at the same temperature, it is well known that inequality is the rule and equality the exception; and, further, that contraction is more frequently observed than expansion on admixture. So far, however, as experimental evidence is available, it appears that when the liquids are very closely related to each other the change of volume is exceedingly small. For example, with ethyl acetate and propionate in equimolecular proportions, +0·015 per cent.; toluene and ethyl benzene, −0·034 per cent.; n-hexane and n-octane, −0·053 per cent.; methyl and ethyl alcohol, +0·004 per cent.; chlorobenzene and bromobenzene, no change.

When the relationship is less close the changes are usually, but not invariably, larger, and are in some cases positive, in others negative; and it is rarely possible, in the present state of our knowledge, to predict from the nature of the substances—unless one is basic and the other acidic in character—whether contraction or expansion is to be expected. Thus, when methyl alcohol is mixed with water considerable contraction occurs, although the relationship is less close than between methyl and ethyl alcohol, which expand to a minute extent on mixing.

All we can say with regard to the alcohols is that, the higher the molecular weight—or, if isomeric alcohols are

[1] The atomic weights [C = 11·97, H = 1] employed in the original papers are retained.

included, the higher the boiling-point—the smaller, as a rule, is the contraction on mixing with water.

Very similar remarks apply to the heat changes which occur on mixing liquids. It appears that in the case of very closely related substances these changes are exceedingly small, or negligible, as is indicated by the very minute change of temperature which has been observed, thus: ethyl acetate and propionate, $-0^{\circ}\cdot02$; toluene and ethyl benzene, $+0^{\circ}\cdot05$; n-hexane and n-octane, $+0^{\circ}\cdot06$; methyl and ethyl alcohol, $-0^{\circ}\cdot10$; chlorobenzene and bromobenzene, $0^{\circ}\cdot00$.

It might be expected that in the case of less closely related substances contraction would be accompanied by evolution of heat and expansion by absorption of heat, but this is by no means invariably the case; for example, on mixing 40 gram-molecules of propyl alcohol with 60 gram-molecules of water there is a contraction of 1·42 per cent., but a fall of $1^{\circ}\cdot15$ in temperature was observed. Taking the alcohols as a group, it is found that, the higher the boiling-point, the smaller is the heat evolution or the greater the absorption on admixture with water.

Properties of Mixtures.

The behaviour of two non-miscible liquids when heated together is well known, and I need only refer to the fact that the vapour pressure is equal to the sum of the vapour pressures of the pure components at the same temperature; that the boiling-point is the temperature at which the sum of the vapour pressures of the components is equal to the pressure under which the liquid is being distilled, provided that evaporation is taking place freely and the vapour is not mixed with air; and, lastly, that the composition of the vapour is independent of that of the liquid (so long as both components are present in sufficient quantity), and is expressed by the equation $\frac{x_A}{x_B}=\frac{P_A D_A}{P_B D_B}$, where x_A and x_B are the relative weights of the two components in the vapour, P_A and P_B their vapour pressures at the observed boiling-point, and D_A and D_B their vapour densities.

The vapour pressure, boiling-point, and vapour composition, then, can be calculated for non-miscible liquids, and it has been stated that such liquids have never any close chemical relationship, and are usually not related at all.

On the other hand, it has been mentioned that when the chemical relationship is very close the liquids are invariably miscible in all proportions, and that there is very little, if any, volume or heat change on admixture.

So, also, the vapour pressure and boiling-point of a mixture of closely related liquids are easily ascertained from those of the pure components, and the composition of the vapour bears a simple relation to that of the liquid.

The vapour pressure of the mixture is given, at any rate with a very close approach to accuracy, by the equation

$$P=\frac{mP_A+(100-m)P_B}{100},$$

where P, P_A, and P_B are the vapour pressures of the mixture and of the components, A and B, at the observed boiling-point, and m is the molecular percentage of A.

Van der Waals concluded from theoretical considerations that this relation should be true when the critical pressures are equal and the molecular attractions agree with the formula proposed by Galitzine and by D. Berthelot, $a_{1\cdot2}=\sqrt{a_1 \cdot a_2}$, where $a_{1\cdot2}$ represents the attraction of the unlike molecules and a_1 and a_2 the respective attractions of the like molecules. That is certainly the case with chlorobenzene and bromobenzene, which, as already mentioned, show no heat or volume change on admixture, for the maximum difference between the observed and calculated pressure in three experiments was less than 0·1 per cent.

But the relation is, at any rate, very nearly true for closely related substances when the critical pressures are not equal, for in the case of methyl and ethyl alcohol the difference between the observed and calculated pressure was within the limits of experimental error, and with four other pairs of closely related substances the greatest mean difference (for three readings each) was only 0·6 per cent. It is not, however, as Speyers suggested, true for all non-associated substances, whether closely related or not; indeed, chemical relationship seems to be much more important than the state of molecular aggregation, for the relation is true for methyl and ethyl alcohol, while it is altogether untrue for benzene and hexane.

The boiling-point of a mixture of closely related liquids may be ascertained from the vapour pressures of the components, but not so simply as in the case of non-miscible liquids, because the boiling-point depends on the composition of the liquid.

In order to calculate the boiling-points of all mixtures of two closely related liquids under normal pressure we should require to know the vapour pressure of each substance at temperatures between their respective boiling-points under that pressure. Thus, chloroform boils at $132^{\circ}\cdot0$, and bromobenzene at $156^{\circ}\cdot1$, and we must be able to ascertain the vapour pressure of each substance between 132° and 156°.

The percentage molecular composition of mixtures which exert a vapour pressure of 760 mm. must then be calculated at a series of temperatures—say every two degrees—between these limits by means of the formula $m=100 \cdot \frac{P_B-P}{P_B-P_A}$, where, in this case, $P=760$.

Lastly, the molecular percentages of A, so calculated, must be mapped against the temperatures, and the curve drawn through the points will give us the required relation between boiling-point and molecular composition under normal pressure. In the case of six pairs of closely related liquids the greatest difference between the observed temperature and that read from the curve constructed as described was $0^{\circ}\cdot27$.

For liquids which are not closely related the differences are usually much greater, and particular mixtures of constant (minimum or maximum) boiling-point are not unfrequently met with, especially when the molecules of one or both substances are associated in the liquid state.

The formula for the composition of the vapour from a mixed liquid suggested independently by Berthelot and by Wanklyn, $\frac{x_A}{x_B}=\frac{W_A P_A D_A}{W_B P_B D_B}$, (where x_A and x_B, P_A and P_B, D_A and D_B, have the same meaning as in the equation for non-miscible liquids, and W_A and W_B are the relative weights of the two components in the liquid mixture), was shown by F. D. Brown to be incorrect, and he proposed the simpler formula, $\frac{x_A}{x_B}=c\frac{W_A}{W_B}$, where c is a constant which does not differ greatly from $\frac{P_A}{P_B}$. The subject was investigated mathematically by Duhem and by Margules, and experimentally and mathematically by Lehfeldt and by Zawidski. The two last-named observers deduced workable formulæ from the fundamental equation of Duhem and Margules, and it is noticeable that both Lehfeldt's and Zawidski's formulæ, in their simplest form, become identical with Brown's. Zawidski's, however, assumes the form $\frac{x_A}{x_B}=\frac{P_A}{P_B}\cdot\frac{W_A}{W_B}$. This formula is certainly not, as a rule, true for mixtures of liquids which are not closely related; but, on the other hand, in the very few cases examined the equation $\frac{x_A}{x_B}=c\cdot\frac{W_A}{W_B}$ appears to hold for those mixtures for which the equation

$$P=\frac{mP_A+(100-m)P^B}{100}$$

is true; that is to say, generally, for closely related liquids.

The question, however, whether $c=\frac{P_A}{P_B}$ is an open one; but it is interesting to remark that if this equality holds it should be possible in many cases to calculate the vapour pressure at any temperature, the boiling-point under any pressure, and the composition of the vapour, of any mixture of two very closely related liquids, if the boiling-point of one of them under any one pressure, and the vapour pressures of the other within sufficiently wide limits of temperature, are known. For the boiling-points on the absolute scale of the two liquids at the same pressure bear a constant ratio to

each other, or $\frac{T_A}{T_B} = \frac{T'_A}{T'_B}$; hence the vapour pressures or boiling-points of one substance can be calculated if those of the other are known. Again, from the vapour pressures of the pure substances we can calculate the vapour pressures and the boiling-points of all mixtures; and, lastly, if $c = \frac{P_A}{P_B}$, we can make use of Brown's formula, $\frac{x_A}{x_B} = c\frac{W_A}{W_B}$, to calculate the composition of the vapour from all mixtures without carrying out special experiments to find the value of c. It is, therefore, a matter of considerable interest to ascertain whether c is really equal to $\frac{P_A}{P_B}$ or not.

When the equation

$$P = \frac{mP_A + (100 - m)P_B}{100}$$

does not hold good, a modification of Brown's formula, or that of Lehfeldt, or of Zawidski, must be employed to calculate the vapour composition, and the constants for those formulæ must first be determined experimentally.

Other physical properties, such as the refractive power of mixtures, might be considered, but I will only refer to the critical temperature and pressure. In 1882 Pawlewski stated that the critical temperature of a mixture could be calculated from those of the components by the formula

$$\theta = \frac{m\theta_A + (100 - m)\theta_B}{100},$$

where m is the percentage *by weight* of A; and G. C. Schmidt, in 1891, carried out experiments to test the correctness of the statement, purposely choosing substances of widely different physical properties. The differences between the calculated and observed temperatures were not, as a rule, very great, rarely exceeding 4°, and Schmidt considered that they might, to some extent, be accounted for by partial decomposition of one or other component.

Such determinations are, however, liable to serious errors. It is exceedingly difficult to fill a tube with the required amount of a liquid mixture of known composition quite free from air, and although the composition of the very small amount of liquid employed might be determined after the experiment from its specific refractive power, it would be necessary to know the specific refractive powers of the two components and of mixtures of them. Schmidt does not state how he prepared his mixtures and determined their composition.

Again, when a liquid mixture is heated in a sealed tube, fractionation goes on, so that the more volatile component tends to accumulate in the upper part of the tube, leaving the less volatile component in excess below, and unless a stirring arrangement, such as that devised by Kuenen, is employed, many hours would elapse before complete admixture by diffusion took place at the critical point.

By far the most important and accurate experiments on this subject have been carried out by past or present pupils of Prof. Kamerlingh Onnes, notably by Prof. Kuenen; and it is quite certain that the formula of Pawlewski cannot be generally true for mixed liquids, for, just as we may have mixtures of minimum or maximum boiling-point, so also, as Kuenen has shown, mixtures of minimum or maximum critical temperature may exist. Thus the critical temperature of carbon dioxide is 31°·1, and of ethane, 32°·0, but that of a mixture containing 30 molecules per cent. of carbon dioxide is 18°·8. The question remains, however, whether some such law as that proposed by Pawlewski may not hold good for closely related substances. In certain cases, when the relationship is very close (for example, C_6H_5Cl and C_6H_5Br), the critical pressures are equal, or very nearly so, and it seems probable that the critical pressure would be the same for any mixture as for the components. Such a case as this would be likely to give the simplest possible relation between the critical temperatures of a mixture and those of its components; and although the critical temperatures of these substances are inconveniently high, there are, no doubt, others which might be employed —perhaps ethyl chloride and bromide, or possibly carbon dioxide and carbon disulphide. I imagine, however, that Pawlewski's formula would be more likely to hold if m represented the *molecular percentage*, and not the percentage *by weight* of A.

In the case of homologous compounds, paraffins, ethers, esters, and so on, the critical pressures are not equal, and it would be necessary to find whether the critical pressures of mixtures are represented by the formula

$$P = \frac{mP_A + (100 - m)P_B}{100}$$

(where m is the molecular percentage of A), and also whether any such simple formula is applicable to the critical temperatures.

Kuenen has made some observations with mixtures of ethane and butane containing 2·5 and 5 molecules per cent. of butane, and at the conclusion of his paper he says: "If there was a simple law connecting the critical constants of mixtures with those of the constituents, we might calculate the constants for the second substance [those of the first being known]. But such is not the case. Pawlewski's law that the critical temperature is proportional to the composition, expressed in weight units, is very inaccurate, the deviations being sometimes considerable in both directions."

It would, I think, be of great interest if Prof. Kuenen could find time to carry out further experiments with mixtures of ethane and butane in order to settle this point, or, perhaps, with *n*-hexane and *n*-octane, both of which can be more easily obtained in a pure state.

From what has been said it may be concluded that, in order to ascertain the normal behaviour of pure substances under different conditions, or to find the simplest relations between the boiling-points, molecular volumes, or other physical constants of a series of substances, or, again, to ascertain the normal behaviour of substances when mixed together, and the properties of the mixtures as compared with those of the components, it is undoubtedly advisable—at first, at any rate—to confine our attention to substances of which the molecules show no signs of association in either the gaseous or liquid state.

In the case of mixtures it is also best to begin with substances which are chemically closely related to each other.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY AUBREY STRAHAN, M.A., F.R.S., PRESIDENT OF THE SECTION.

It is forty-two years since the British Association last met in Cambridge, and we may turn with no little interest to the record of what was taking place at a date when the science of Geology was still in its infancy, and in a University where its promise of development was first recognised. Dr. John Woodward, the founder of the Woodwardian Chair, had been dead 176 years, but his bequest to the University had not long begun to bear fruit, for the determination to house suitably the collection of fossils and to provide for the reading of a systematic course of lectures was not arrived at until 1818. In that year Adam Sedgwick, on his appointment to the Woodwardian Chair, began a series of investigations into the geology of this country, which made one of the most memorable epochs in the history of British Geology. At the Cambridge meeting of 1862 he had therefore held the professorship for forty-four years, a period sufficient to spread his reputation throughout the civilised world as one of the pioneers of geological science.

Towards the close of his life Sedgwick gave expression to the objects which he had had in view when he accepted a professorship in a science to which he had not hitherto specially devoted his attention. "There were three prominent hopes," he writes, "which possessed my heart in the earliest days of my Professorship. First, that I might be enabled to bring together a Collection worthy of the University, and illustrative of all the departments of the Science it was my duty to study and to teach. Secondly, that a Geological Museum might be built by the University, amply capable of containing its future Collections; and lastly, that I might bring together a Class of Students who would listen to my teaching, support me by their sympathy, and help me by the labour of their hands."

We, visiting the scene of his labours more than thirty years after he wrote these words, witness the realisation of Sedgwick's hopes. The collection is not only worthy of the University, but has become one of the finest in the kingdom. It is housed in this magnificent memorial to the name of Sedgwick, on the completion of which I offer for myself, and I trust I may do so on behalf of this Section also, hearty congratulations to the Woodwardian Professor and his staff. Finally, I may remind you that at this moment the Directorship of the Geological Survey and the Presidential Chair of the Geological Society are held by Cambridge men; that the sister University has not disdained to borrow from the same source; and lastly, that it is upon Cambridge chiefly that we have learned to depend for recruiting the ranks of the Geological Survey, as proofs that Cambridge has maintained her place among the foremost of the British schools of Geology.

Though he had taken a leading part at former meetings of the Association, Sedgwick's advanced age in 1862 necessitated rest, and this Section was deprived to a great extent of the charm of his presence. It benefited, however, in the fact that the Presidential Chair was occupied by one of his most distinguished pupils. Jukes was one of those men the extent of whose knowledge is not readily fathomed. It has been my experience, and probably that of many others in this room, to find that some conclusion, formed after prolonged labour and perhaps fondly imagined to be new, has been arrived at years before by one of the old geologists. Such will be the experience of the man who follows Jukes's footsteps. Turning to his Address given to this Section in 1862, we find much of what is now written about earth-movement and earth-sculpture forestalled by him, with this difference, however, that whereas the custom is growing of using a phraseology which may sometimes be useful, but is generally far from euphonious, and not always intelligible, he states his arguments in plain, forcible English.

It may raise a smile to find that Jukes thought it necessary in 1862 to combat the view that deep and narrow valleys had originated as fissures in the crust of the earth, and that the Straits of Dover must have been formed in this way, because the strata correspond on its two sides. But we shall do well to remember that the smile will be at the public opinion of that day, and not at Jukes himself. In no branch of Geology have our views changed more than in the recognition of the potency of the agents of denudation. In 1862 it was necessary to present preliminary arguments and to draw inferences which in 1904 may be taken as granted.

The evidences of the prodigious movements to which strata have been subjected, and of the extent to which denudation has ensued, cannot fail to strike the most superficial observer. Both mountain and plain present in varying degree proof that sheets of sedimentary material originally horizontal are now folded and fractured. But after a momentary interest aroused by some example more striking than usual, glimpsed, it may be, from a train-window, the subject is probably dismissed with an impression that such phenomena are due to cataclysms of a past geological age, and have little concern for the present inhabitants of the globe. These stupendous disturbances, it might be argued, can only have taken place under conditions different from those which prevail now. We are familiar with mountain-ranges in which their effects are conspicuous; we have carried railways over or through them and have been troubled by no cataclysmic movements of the strata. Apparently the rocks have been fixed in their plicated condition, and are liable to no further disturbance. Parts of the world, it is true, are subject to earthquakes accompanied by fissuring and slight displacement of the crust, but not even in earthquake regions can we point to an example of such thrusting and folding of the strata being actually in progress as have taken place in the past. Nor, again, can volcanic activity be appealed to, for some of the most highly disturbed regions are devoid of igneous rocks. Volcanic eruptions are more probably the effect than the cause of the disturbances of the crust. Nowhere in the world therefore, it will be said, can we see strata undergoing such violent treatment as they have experienced in the past. How, then, can we dispute the inference that the forces by which the folding was produced have ceased to operate?

Before accepting a conclusion which would amount to admitting that the globe is moribund and that the forces by which land has been differentiated from sea have ceased to act, we shall do well to look more closely into the history of the earth-movements to which any particular region has been subjected. The investigation is one which calls for the most intimate knowledge of the geological structure, and, as time will admit of my dealing with a small area only, I shall confine my observations to England and Wales, selecting such facts as have been established beyond dispute.

At the outset of the investigation we find reason to conclude that the movements, so far as any one region is concerned, have been intermittent. Evidence of this fact is furnished wherever any considerable part of the geological column is laid open to view. Sheets of sediment, aggregating perhaps thousands of feet in thickness, have been laid down in conformable sequence, all bearing evidence of having been deposited in shallow seas. The inference is inevitable that that period of sedimentation was a period of uninterrupted subsidence. But sooner or later every such period came to an end. Compression and upheaval took the place of subsidence, and the strata lately deposited were plicated and brought within the reach of denudation. Illustrations of the recurrence of these movements abound, and I need dwell no further upon them than to remark that movements of subsidence and upheaval may be seen to have alternated wherever opportunity is afforded for observation.

On extending our observations we are led to infer that the movements of the crust were developed regionally, not universally. The areas of subsidence, for example, evidenced by the marine formations, had their limits, though those limits did not coincide with the shores of existing seas, nor has reason been found to believe that the proportion of land to sea has varied greatly in past times. The limits of the area affected by any one movement of upheaval are more difficult to determine, but the effects were manifested in the crumpling up of comparatively narrow belts of country, and are easy of recognition.

Further than this, we ascertain that the movements of one region were not necessarily contemporaneous with those of adjoining regions. The forces operating upon the crust of the earth came into activity in different places at different times, and, while some continental tracts have been but little disturbed from early geological times, there are parts of the globe which have been the scene, so to speak, of almost ceaseless strife. Among the latter we may include the British Isles.

These are commonplaces of Geology, and I mention them merely to emphasise the fact that the geological structure of these islands is the result of movement superimposed upon movement. Obviously, therefore, in order to gain a comprehensive view of the operations which were in progress in any one region during any one epoch, we have to find some means of distinguishing the movements of that epoch and of eliminating all which preceded or followed it. This, briefly, is the problem which has engaged the attention of geologists for many years past, and upon which I propose to touch.

The determination of the age of a disturbance is seldom easy, and among the older Palæozoic rocks is often impossible; but at the close of the Carboniferous period, during the great continental epoch which led to and followed upon the deposition of the Coal Measures, there came into action a set of movements of elevation and compression which generally can be distinguished both from those which preceded them and from those which have been superimposed upon them. The distinction depends upon the determination of the age of the rocks affected by the movements. For example, a movement by which the latest Carboniferous rocks have been tilted from their original horizontal position is obviously post-Carboniferous. On the other hand, if Permian rocks lie undisturbed upon those tilted Carboniferous rocks it is equally obvious that the movement was pre-Permian. Now it happens that earth-movements of the date alluded to were particularly active in the British Isles, and played an important part in shaping the platform on which the Permian and later rocks were laid down. Though they have been more completely explored than others in the working of coal, their further investigation is of the greatest economic importance. I have attempted, therefore, briefly to sketch out the principal lines along which earth-movements of that age came into operation in England,

premising, however, that by Permian I mean the Magnesian Limestone series, and not the "Permian of Salnpian type," which is now known to be partly of Triassic but principally of Carboniferous age. In the course of the investigation we shall find reason to conclude that several at least of the movements followed old axes of disturbance, lines of weakness dating from an early period in the history of the habitable globe; and, again, that some of the latest disturbances of which we have cognisance were but renewals of movement along the same general lines.

One of the most clearly proved examples of pre-Permian faulting in the Carboniferous rocks occurs in the Whitehaven Coalfield. The fault forms the south-eastern limit of the Coal Measures, and has been precisely located for a distance of six miles. In its course towards the south-west it passes under five outliers of Permian rocks, and finally is lost to sight under the Permian and Trias of St. Bees. The dislocation in the Carboniferous rocks amounts to about 400 yards, but the Permian rocks have not been even cracked; though broken and displaced by numerous faults of later date, they pass undisturbed over this great dislocation, the movement along it obviously having ceased before they were deposited. This fault forms part of the upheaval which brought the older rocks of Cumberland and Westmorland to the surface, and in that sense it may be said to form the north-western frontier of the Lake District.

On the north-eastern side also of the Lake District the Permian rocks rest upon uptilted Carboniferous strata, but the axis of upheaval runs in a north-north-westerly direction and defines what we may regard as the north-eastern frontier. Along this frontier much movement has taken place in post-Permian times, but the unconformable relations of the Permian and Carboniferous rocks enable us to distinguish that part of the tilting which intervened between the two periods. On the south-eastern frontier also the Carboniferous rocks had been upheaved and denuded before the Permian sandstones were laid down. A huge fault, along which Carboniferous rocks have been jammed from the east in a multitude of plications against Silurian, runs from Kirkby Stephen by Dent to Kirkby Lonsdale, and thence trends south-eastwards by Settle. It is highly probable, though it has not been proved, that this fault is of pre-Permian age. That the Pendle axis which upheaves the Lower Carboniferous rocks between Settle and Burnley is pre-Permian is placed beyond doubt by the fact that an outlier of Permian rests upon the denuded crest of the anticline near Clitheroe.

The south-western frontier is defined by a still more marked unconformable overlap by the Permian strata, which here pass over the edges of the lowest members of the Carboniferous series and come to rest upon the Lake District rocks.

We have thus defined the sides of an oblong tract which was upheaved in the period we are considering. The older rocks forming the northern part of that tract had already had imposed upon them a dominant north-easterly strike by a pre-Carboniferous movement of great energy. As a result also of that and other movements they had been subjected to vast denudation, not only in the Lake District, but throughout the north-west of England generally. But while it is doubtful whether any of the physical features then produced have survived, it seems to be beyond dispute that it was in consequence of the pre-Permian movements that the older rocks of the Lake District were freed from their Carboniferous covering, and that to this extent the district may be said to have been blocked out in pre-Permian times. The detailed sculpturing resulted from later movements, with which we are not now concerned.

During this same period there rose into relief that part of the Pennine axis which runs between Lancashire and Yorkshire. The doming up of the Lower Carboniferous rocks and the wildness of the moorlands which characterise their outcrops have impressed all who have had occasion to cross from the one populous coalfield to the other, and have gained the name of the "backbone of England" for this anticlinal axis. Whether, however, it can be regarded as one axis or as the result of several movements is doubtful, but not material for our present purpose. Regarded as a geological structure it is not continuous with that part of the Pennine axis which runs along the north-eastern frontier of the Lake District.

Passing westwards from the Pennine axis we cross the deep and broad Triassic basin of Cheshire, which may be regarded as the complement of the dome of elevation of Derbyshire. To the west of this, again, we reach a part of North Wales which was more or less shaped out by the earth-movements which came into action between the Carboniferous and Permian periods. Two leading faults traverse the district. The one runs in a north-north-westerly direction across Denbighshire and introduces that little bit of "Cheshire in Wales" known as the Vale of Clwyd. Though there has been some later movement along this fault, it was in the main pre-Triassic, which statement, in view of the perfect conformity between the Permian and Trias, amounts to saying that it was pre-Permian. The other passes across Wales in a north-easterly direction along the Dee Valley at Bala, and reaches the Triassic basin between Chester and Wrexham. The date of this fault has not been worked out in detail, but the fact that it is associated with a pre-Triassic anticline, where it reaches the Triassic margin, proves that it is in part at least of pre-Triassic age. In Anglesey also there has been strong post-Carboniferous folding in the same N.E.–S.W. direction.

It is to be noticed, further, that the Carboniferous rocks maintain their characters to their margins on the flanks of the Clwydian Hills and other ranges of Silurian rocks in North Wales. Both along the coast, and even in a little outlier preserved near Corwen by an accident of faulting, they show a persistence of type and of detail in sequence which could hardly have been maintained had the Silurian uplands existed in Carboniferous times. The inference that the uplands of Denbighshire and Flintshire are the result of post-Carboniferous upheaval is strengthened by the fact that the Carboniferous rocks reposing on their flanks are tilted at an angle which would carry them over their tops. This part of North Wales, therefore, presents a history corresponding in its main events with that of the Lake District. It had undergone elevation and denudation in pre-Carboniferous times on a scale so vast that rocks showing slaty cleavage and other indications of deep-seated metamorphism had been laid bare. But in both cases it was in consequence of the post-Carboniferous movements that the leading physical features as they exist to-day began to take shape.

In both these regions pre-Carboniferous movements had been extremely active. For example, an axis of compression and upheaval ranges from N.E. to S.W., involving the Lake District, the Isle of Man, and Anglesey. It belongs to the Caledonian system of disturbances which is developed on a large scale further north, and which sufficed here to cause slaty cleavage and presumably the extrusion of the Shap granite. I mention this pre-Carboniferous axis to point out that it offers an explanation of the direction taken by the post-Carboniferous disturbances of Whitehaven, Pendle, Anglesey, and possibly Bala. With the exception of the last-named they lie well within the region affected, and alone among the post-Carboniferous axes take that particular direction.

The Pennine axis ends as a physical feature in South Derbyshire and North Staffordshire on the margin of a deep channel filled with Triassic marl, which extends westwards from Nottingham into Shropshire. In this part of England there springs into existence a remarkable series of disturbances tending to radiate southwards. The westernmost of these is the great fault which forms the western boundary of the North Staffordshire Coalfield. Recent work by Mr. W. Gibson has shown that the vertical displacement of the Coal Measures amounts to no less than 900 yards, but that it is far less, though recognisable, in the Trias, proving that the disturbance was in the main pre-Triassic. The fault ranges from Macclesfield in a south-south-westerly direction, is lost to view under the Trias near Market Drayton, but it is recognisable further on in the great dislocation which passes along the western side of the Wrekin, and thence through Central Shropshire by Church Stretton to Presteign in Radnorshire, and thence into Brecknock.

The second is the Apedale Fault of the North Staffordshire Coalfield. In working the coal this disturbance has

been found to possess the structure of a broken monocline, a fold with fracture such as may be regarded as an early stage in the formation of an overthrust from the east. It runs through the coalfield in a direction slightly east of south, and then passing under the Trias of Stafford ranges for Wolverhampton and Stourbridge. This fault is mainly pre-Triassic, but what Mr. Gibson believes to be a continuation of it, following the same direction as far south as Hanbury, certainly effects a great movement in the Trias.

The third disturbance runs on the east of the Forest of Wyre Coalfield in a direction a little west of south. Here, as I learn from Mr. T. C. Cantrill, the thrust from the east is obvious, for Old Red Sandstone has been pushed from that direction against and even over Coal Measures, while the strata have been forced up into a vertical position for some miles. In South Staffordshire all the Carboniferous rocks, including the "Salopian Permian," are involved in this and the previously mentioned movement, proving that both disturbances were of post-Carboniferous date.

Traced southwards this disturbed belt leads to Abberley, and there connects itself with the well-known Malvernian axis. The broken belt known by that name runs north and south, and may be followed almost continuously from Worcestershire to Bristol. It presents evidence of having been a line of weakness through a large part of the world's history, as shown by Prof. Groom, and of having yielded repeatedly to earth-stresses; but there is seldom difficulty in distinguishing the movements which were effected during the period under consideration. For example, near and south of Abberley the Coal Measures are clearly involved in a thrust from the east, which was sufficiently energetic to turn over a great belt of Old Red Sandstone and other rocks beyond verticality for some miles. Further south, again, among repeated proofs of the ridging up of the old axis in several pre-Carboniferous periods, we find evidence of post-Carboniferous elevation along the same general line. Throughout this same region there has been also post-Triassic dislocation, which, however, is on a comparatively small scale. That the Carboniferous rocks were greatly disturbed before the Trias was laid down is proved by the great unconformity between the two formations.

The Malvernian axis continues southwards by Newent, but perhaps with diminishing intensity. On its west side a broad syncline rolls in the tract of Carboniferous rocks which underlies the Forest of Dean. The syncline trends north and south, and is shown to be of pre-Triassic age by the fact that the Triassic strata on the banks of the Severn do not share in the synclinal structure. Here we must leave the Malvernian axis for the present.

The fourth disturbance ranges along the Lickey Hills, which, diminutive as they are, tell a story of great geological significance. They range in a south-south-easterly direction, and in the fact that they are formed of extremely ancient rocks furnish evidence of immense upheaval. From the relations of these ancient formations to one another we may gather also that the upheaval was due to a recurrence of movement along the same axis at more than one geological date, but at the same time we find no difficulty in distinguishing that part of the movement which took place between Carboniferous and Triassic times, for the Coal Measures are tilted up on end along the flanks of the axis, while the Trias passes horizontally over all the tilted rocks. A clue to the southward extension of the axis under the Secondary rocks is furnished by some faulting as far as Redditch, here also there having been a renewal of movement on a small scale in post-Triassic times.

The fifth disturbance runs through Warwickshire, and includes the low ridge of ancient rocks which ranges through Atherstone and Nuneaton in a south-easterly direction. About fifteen miles to the north-east Archæan rocks form the parallel ridge or series of ridges of Charnwood Forest, while the intervening space is overspread by Trias, resting partly on Carboniferous and partly on older strata. The structure of the Carboniferous and older strata is dominated by what is known as the Charnian movement, which includes disturbances of several ages ranging in a south-easterly direction. That part of the movement which was post-Carboniferous is identifiable by the fact that Coal Measures are tilted on either side of the ridges of old rocks. They once overspread both ridges, but were removed by denudation as a consequence of upheaval before the Trias was deposited. It has been found also in working the coal, as I am informed by Mr. Strangways, that there are large faults having the south-eastward or Charnian direction which shift the Coal Measures, but do not break through the overlying Trias. The evidence, therefore, of a great Charnian movement having taken place during the period under consideration is conclusive. The disturbance ranges as a whole in the direction of Northampton, where in fact borings have reached the Charnwood rocks at no great depth.

The five great disturbances which I have briefly indicated tend to converge northwards, but their exact connection with the Pennine axis is not known. What may be only a part of that axis trends for Charnwood through a tract of Lower Carboniferous rocks exposed at Melbourne, between the Yorkshire and Leicestershire Coalfields, but the Triassic channel I have already mentioned intervenes, and the structure of the rocks underlying the red marl is unknown. The channel itself appears to be of Triassic age, for not only is the depth of marl in it suggestive of its having been a strait in the Triassic waters, but its northern margin has been found by Mr. Gibson to coincide with, and perhaps to have been determined by, faults known to be mainly of pre-Triassic age. One of these, with a downthrow of 400 yards to the south, runs from Trentham through Longton, and south of Cheadle, while another ranges from near Nottingham to the north of Derby.

We come now to the south-west of England, where we find striking proofs of a still more energetic movement than any yet mentioned having intervened between the Carboniferous and Triassic periods. The central part of the Armorican axis, as it has been called, after the ancient name of Brittany, trends nearly east and west, and keeps to the south of our South Coast; but we have opportunities in Devon and Cornwall of seeing some of the stupendous effects produced along its northern side. A belt of country measuring some 130 miles in width has been completely buckled up. Slaty cleavage was superimposed upon the intricate folds into which the strata were being thrown, while after or towards the close of these phenomena granite was extruded at several points along the belt of disturbance, a little north, however, of the line along which the oldest rocks were brought up to the surface. In Devon the Culm-measures are fully involved in the movement, but on the other hand the Permian strata, while containing fragments of the cleaved and metamorphosed rocks, are themselves wholly free from such structures. The age of the folding, cleavage, and extrusion of the granite is thus definitely fixed as having been subsequent to the deposition of the Culm-measures, but previous to that of the Permian rocks.

But we may fix the age still more closely. A broad syncline of Carboniferous rocks traverses Mid-Devon, and is succeeded northwards by an anticline and by an extrusion of granite at Lundy Island, the age of which, however, has not yet been definitely ascertained. Still further north in a series of folds and overthrusts which traverse the southern margin of South Wales we can recognise the last effects of the great Devonshire movement at a distance of not less than 130 miles from the central axis, the ground-swell, so to speak, subsiding as it receded from the distant storm-area. Here the higher Carboniferous rocks are involved, and thus prove that this part at least of the Armorican disturbance was of post-Carboniferous age.

In Dorset, Somerset, and Gloucestershire the Palæozoic rocks pass eastwards under Secondary formations, and are seen no more in the south of England. That the disturbance continues, however, is inferred from the fact that it has been traced across a large part of the continent of Europe in the one direction and across the south of Ireland in the other. The determination of its position therefore, and especially of the effects of its intersection with the Midland disturbances, is of the greatest importance in view of the possible occurrence of concealed coalfields under the Secondary rocks. One such intersection is open to observation.

The Malvern and Devonshire disturbances intersect in Somerset. On investigating their behaviour as they

approach we may notice in the first place that the subsidiary axes which form the northernmost part of the Devonshire disturbance in South Wales die away one after the other towards the east. Thus an east and west disturbance at Llanelly runs a few miles and disappears. The more important Pontypridd anticline, which traverses the centre of the coalfield, fades away near Caerphilly, while the coalfield itself terminates a little further east, its place on the same line of latitude being taken by the Usk anticline, which trends southwards and south-westwards. So far it might be inferred that the east and west folds die away on approaching the north and south Malvernian axis. But the Cardiff anticline, which lies south of and was more energetic than those mentioned, crosses the Bristol Channel and, emerging on the other side in a complicated region near Clevedon and Portishead, passes to the north of Bristol and holds its course right across the coalfield at Mangotsfield. The coalfield, however, lies in what is part of the Malvernian disturbance, for it occupies a syncline running north and south along the west side of the main axis of upheaval. Though the interruption is local and the strata recover their north and south strike to the south of it, yet the east and west axis obviously holds its course right through the Malvernian structure.

Still further south in the direction in which the east and west movements gradually increase in energy a series of sharp folds is well displayed in the coast of South Wales and in an island in the Bristol Channel, ranging for that part of the east and west disturbance which is known as the Mendip axis. This name has been applied to a series of short anticlines which are arranged *en échelon* along a line ranging east-south-east, but each of which runs east and west. Among them we may distinguish the Blackdown anticline, the Priddy anticline, the Penhill anticline, north of Wells, and the Downhead anticline, north of Shepton Mallet. With one exception they all die out eastwards after a course of two to ten miles, but the Downhead anticline holds its course into the Malvernian disturbance, the two engaging in a prodigious *mêlée* south of Radstock. From that much shattered region the Downhead anticline emerges, but the Malvernian axis is seen no more, and, so far as can be judged under the blanket of Secondary rocks, comes to an end.

Mention has been made of the fact that many of the subsidiary east and west folds die away on approaching the Malvernian axis. In a general way we may attribute their disappearance to the influence of the north and south movement, for it is commonly to be observed in these great belts of disturbance that they are composed of a number of parallel anticlines or elongated domes of upheaval, constantly replacing one another; it is a common feature also that these subsidiary folds replace one another not exactly in the direction in which they point, but that they lie *en échelon* along a line slightly oblique to it. The behaviour of the South Wales and Mendip folds is in accordance with these observations, and may be taken to indicate that the effects of the east and west disturbance reached further north in South Wales than they did in Somerset, or, in other words, that they failed to penetrate as far into the region where north and south movements were in progress as in the region where there were no movements of that direction.

The fact that the east and west folds keep their course across the north and south wherever the two actually meet comes out prominently, and supports the inference that they dominate the structure of the Palæozoic rocks which lie hidden beneath the Secondary rocks of the south and south-east of England. Somewhere under this blanket of later formations the east and west axis presumably intersects the other disturbances which traverse the Midlands. To ascertain where and how the intersections take place will be going far towards locating any concealed coalfields which may exist; but the knowledge can be obtained only by boring, and the number of such explorations as yet made is wholly insufficient. The majority have been made in search of water, and have been stopped as soon as a supply was secured. Near Northampton the older rocks were reached at a small depth on what is believed to be the underground continuation of the Charnian axis, and a boring at Bletchley traversed what is thought to have been a great boulder of Charnian rock, suggesting that the axis is not far off; but with these exceptions the counties of Oxford, Buckingham, Bedford, Huntingdon, Cambridge, and Norfolk are unknown ground. Yet under these counties the axes must run if they keep their course. Where exposed at the surface each post-Carboniferous syncline between two axes contains a coalfield. It remains to future exploration to ascertain whether similar conditions hold good under the Oolitic and Cretaceous areas of Central England.

In speaking of the north and south disturbances I have in more than one case stated that the post-Carboniferous movement was but a renewal of activity along an old line of disturbance. The fact is proved by the unconformities visible among the pre-Carboniferous rocks, and it is important for the reason that the geography of this part of the globe at the commencement of the Carboniferous period had been determined by these movements. It has long been known, for example, that the parts of the counties of Stafford, Warwick, and Leicester traversed by the axes of upheaval were not submerged till late in the Carboniferous period. On the other hand, some of the area lying immediately west of the Malvernian axis was submerged at an earlier date, as is shown by the existence of Carboniferous Limestone at Cleobury Mortimer and, in greater development, in the Forest of Dean. The borings near Northampton also proved the presence of Carboniferous Limestone, a fact which is in favour of the occurrence of concealed coalfields, in so far as it indicates that the whole Carboniferous series may have once existed there. It is remarkable that none of the borings in the south and east of England have touched Carboniferous Limestone, all having passed into older or newer rocks. The existence of that formation is neither proved nor disproved.

The determination of the age of these disturbances and a discussion of the pre-Carboniferous geography may seem at first sight to be only of scientific interest, but that problems of great economic importance are involved has been shown recently. It has long been known that the principal coal-seam of South Staffordshire deteriorates westwards as it approaches the pre-Carboniferous ridge evidenced in the neighbourhood of Wyre Forest. There seemed, however, to be no theoretical reasons why it should not keep its characters on either side of the fault which forms the western boundary of the South Staffordshire Coalfield, inasmuch as that fault came into existence after the deposition of the Coal Measures. A shaft recently sunk has proved the correctness of the inference. The seam has been found to be well developed to the west of the fault, and a considerable addition has been made to our productive coalfields.

So much has been written about the range of the Devonshire disturbance under the south of England that I shall add no more than a brief comment on some of the evidence on which reliance has been placed. We have seen that there has been some post-Triassic movement along old lines of disturbance in North Wales and the Midlands and along the Malvern axis. It is suggestive therefore to find that in the region which we believe to be underlain by the east and west disturbance, east and west folding forms the dominant structure of the Secondary and Tertiary rocks.

The anticlines of the Vales of Pewsey and Wardour, the London syncline, the Wealden anticline, the Hampshire syncline, and the anticline of the Isles of Wight and Purbeck, not only lie in the range of the axis, but show an increasing intensity southwards, towards what we may suppose to have been the most active part of that axis. A similar structure prevails in the Oolitic rocks also. They too had been thrown into east and west folds before the Cretaceous period, and this earlier set of movements also grew in intensity towards the south. It would seem then at first sight that the structure of the later rocks gives an easy clue to the structure of the older rocks buried beneath them. This is by no means the case. That the movements manifested in the Oolitic and Cretaceous rocks followed the same general line as the older movement admits of little doubt, but that the later structures correspond in detail with the earlier is improbable.

A brief examination of the region where the Carboniferous rocks disappear under the Secondary formations will give the grounds for this statement. There we find that the Trias passes over the complicated flexures of the Mendip axis in undulations so gentle as to prove that those flexures

had been completed before it was deposited. Nor again do the members of the Oolitic group of the rocks cropping out in succession further east show any such folds as those visible in the Carboniferous, and it is not until we have passed over a considerable tract of Secondary rocks in which there are no signs of east and west folding that we reach the anticlines of the Vales of Pewsey and Wardour. Nor can we then fit these folds in the Cretaceous formation on to any visible axes in the Carboniferous rocks. In these circumstances it would be unjust to suppose that such synclines and anticlines as those of the London and Hampshire basins, or of the Weald, coincide with previously formed synclines and anticlines in the older rocks. They give a clue to the position of the old axis, but not necessarily to the details of its structure. Yet it is upon the determination of the position of the older anticlines and synclines, and of their intersection with the north and south disturbances, that we must depend for locating concealed coalfields. So far but little has been done in the forty-eight years since the question was first mooted by Godwin-Austen. The existence of a coalfield in Kent has been proved, and what appears to be a prolongation of a disturbance from the Pas de Calais along the south-western side of it. The other borings which have reached the Palæozoic floor round London and at Harwich have thrown but little light on the details of its structure. By far the greater part of the ground remains yet to be explored.

In this brief review of the earth-movements of one period, as manifested in one small part of the globe, we have found reason to conclude that they were the result of compression and upheaval; that the crust yielded to the compression by overthrusting and buckling along certain belts; that these belts in the north of England and the Midlands ran for the most part north and south, diverging, however, to the south-west and to the south-east, while in the south of England they took an east and west direction and concentrated themselves along a belt of country which presents the phenomena of crushing on a stupendous scale. We have touched in two cases the flanks of a mountain-range, the Caledonian, which was built and ruined before the Carboniferous period; the Armorican, which was built after that period, and which, though it has stirred so recently as the late Tertiary period, and so energetically as to initiate the physical features and river-system of the south of England, yet expended the greater part of its energy before the Permian period. Lastly, we have found evidence, in the majority of cases, that the disturbances were but renewals of movement along lines of weakness long before established, and that in several cases there has been further renewal along the same lines during successive periods later than the one we have considered. With such a history before us, and with the knowledge that mountain-ranges have been built in other parts of the world by the upheaval of strata of almost recent date, we have more cause to wonder that the internal forces have left this quarter of the globe alone for so long, than reason to believe that they have ceased to exist. Changes of level, however, have taken place in comparatively recent times, and are now in progress. Though almost imperceptibly slow, they serve to remind us that a giant lies sleeping under our feet who has stretched his limbs in the past, and will stretch them again in the future. Nor in view of the fact that the structures I have described have only been revealed by the denudation of vast masses of strata does it seem unreasonable to suppose that they are deep-seated phenomena. The slow changes of level may be the outward manifestation of more complicated movements being in progress at a depth.

It is interesting to speculate on what appearance the globe would have presented had it not been enveloped in an atmosphere and covered for the most part with water. Owing to those circumstances it possesses the power of healing old wounds and burying old scars. In their absence we may suppose that the belts of crushing and buckling would have given rise to ridges growing in size at every renewal of movement, for they would have been neither levelled by denudation nor smoothed over by sedimentation. This globe, we may suppose, would have appeared to the inhabitants of another planet as being encompassed in a network, and we are prompted to ask whether our astronomers can distinguish in any other planet markings that may be attributable to this cause. I must remind you, however, how much more remains to be done than I have been able to touch upon to-day. The map [appended to the address] represents one episode only in a long series of events, and a series of such maps would be required to illustrate the first appearance of lines of weakness in the earth's crust, the subsequent renewals of movement along those lines, and the formation of new lines in successive geological periods. With the case thus set out we shall be justified in appealing to the physicists for an explanation of the restlessness of this globe.

NOTES.

THE Antarctic relief ship *Terra Nova* arrived at Plymouth on Sunday night last, and afterwards left for Sheerness. It will be remembered that the *Terra Nova*, in company with the *Morning*, was engaged in the expedition for the relief of the *Discovery*, which was ice-bound in the Antarctic Sea. The two relief ships left Hobart together, and first encountered pack ice on January 4. They saw the mastheads of the *Discovery* on January 8, and the crews of the three ships were engaged from that time until February 14 in blasting a passage through the 12 miles of ice which lay between the *Discovery* and open water. When they got within two miles of the *Discovery* the ice began to break up freely, and the task was quickly completed. The *Discovery*, having been supplied with coal by the *Terra Nova*, began her homeward journey, the two vessels during the early stages travelling in company. Subsequently the vessels parted owing to bad weather, but met again at the Auckland Isles. Thence they proceeded to Lyttelton and home.

THE first instalment of specimens collected by the National Antarctic Expedition in the *Discovery* has, according to the *Times*, arrived at the British Museum (Natural History). It consists of the collection of sealskins obtained by the expedition in the pack ice and in McMurdo Strait in the Polar summers of 1901–2, 1903–4. It is proposed to await the arrival of the *Discovery* before dealing with this instalment, which has been sent on ahead in order to ensure the proper preservation of the specimens; but the report which has been received with the collection indicates that the four species of true seals known to occur in the Antarctic are all represented. It is probable that the collection also contains one or more specimens of the elephant-seal from McMurdo Strait, a region where it was not hitherto known to exist. The remainder of the specimens collected by the expedition are coming home in the *Discovery*. On the arrival of the *Discovery*, the natural history specimens will be sent to the Cromwell Road Museum to be worked out, the trustees of the British Museum having, says the *Times*, undertaken the classification, description, and publication of the biological and geological results of the expedition.

WE much regret to have to announce the death, in his seventy-fourth year, of Dr. J. D. Everett, F.R.S., for thirty years professor of natural philosophy at Queen's College, Belfast.

WE note with great regret the death of the Rev. Dr. H. P. Gurney, principal of the Durham College of Science, Newcastle-upon-Tyne, which occurred on Saturday last through a fall while climbing in the Alps. Dr. Gurney, who did much to further the interests of science and education, became principal of the Durham College of Science in 1894, and was also professor of mathematics and lecturer in mineralogy in the same institution. In Newcastle he was a recognised leader in educational matters, and was a co-opted member of both the Newcastle and the Northumberland education committees, being particularly useful on the higher and other sub-committees.

It was arranged some time ago to promote a public memorial to Sir Thomas Browne, the author of "Religio Medici," and the executive committee to which was entrusted the work of carrying out the scheme has commissioned Mr. Henry Pegram, A.R.A., to make a statue for erection in the Haymarket, Norwich.

It is the intention of the Senate of the University of Heidelberg to establish a gold medal in honour of Prof. Kuno Fischer, and to award the same every five years for work on the history of philosophy in Germany.

According to the *Journal* of the American Medical Association, the sum of 500*l.* has been placed with the authorities of the University of Heidelberg to award a prize every three years for the best therapeutic achievement during the previous three years published first in German literature. The donor is Prof. Czerny, and the gift is in honour of the clinician Adolf Kussmaul, on whose birthday the prize is to be awarded.

A movement is on foot in Bombay, according to the *Pioneer Mail*, to provide a memorial to Mr. J. N. Tata, the munificent donor of the research institute in India, and a preliminary meeting to further the object was recently held, at which a provisional memorial committee was formed. It was resolved to call a public meeting to decide as to the best way of perpetuating the memory of Mr. Tata.

The title of *grand officier de la Légion d'honneur* has been conferred upon M. Tillaux, president of the Paris Academy of Medicine. Prof. Blondlot, well known for his researches with *n*-rays, has been promoted to be *officier*, and M. J. Liégeois becomes *chevalier*.

According to a Reuter telegram of Sunday last from Athens, violent and repeated earthquake shocks have been felt in the island of Patmos, causing severe damage. Several houses were destroyed in the villages.

The Alexandria correspondent of the *Daily Chronicle* reports that a severe earthquake, moving in a north-westerly direction, was felt at Suez early on Monday morning last.

The sixth International Zoological Congress opened at Berne on Monday last under the presidency of Prof. Studer, of Berne. The next congress will be held at Boston, Mass., in 1907.

The annual meeting of the Association of German Men of Science and Medical Practitioners is to be held this year at Breslau from September 18 to 24.

The department of medicine (under the chairmanship of Prof. Osler) of the forthcoming International Congress of Arts and Science which is to take place in connection with the St. Louis Exposition from September 19 to 25, is to be divided into the following twelve sections:—Public health, preventive medicine, pathology, therapeutics and pharmacology, internal medicine, neurology, psychiatry, surgery, gynæcology, ophthalmology, otology and laryngology, and pædiatrics. According to the *British Medical Journal* the following English medical men will take part in the proceedings, viz.:—Major Ronald Ross, C.B., F.R.S., in the section of preventive medicine; Sir Lauder Brunton, F.R.S., in that of therapeutics and pharmacology; Prof. Clifford Allbutt, F.R.S., in that of internal medicine; and Sir Felix Semon, C.V.O., in that of otology and laryngology.

The New York Board of Health has voted the sum of 2000*l.* to defray the expenses of a commission of experts whose duty it shall be to inquire into the prevalence of pneumonia, and to suggest means of checking the evil.

According to the *Westminster Gazette*, the formation of a National League for Physical Education and Improvement has been suggested, the object of which is to render assistance to all the bodies at present working for the health of the people to extend the benefits of training throughout the country. The movement is the outcome of the recently issued report of the committee on physical deterioration, upon which we commented last week, and it has, we understand, the support of many influential medical men and others.

An exhibition of mineral products and hydraulic machinery is to be held in Barcelona next month, and the time for receiving applications for space from intending exhibitors has been extended up to August 31. Exhibits themselves coming from abroad will be received even after the exhibition has been opened.

It is reported in *Engineering* that the Government has decided to establish a wireless telegraph station on the Marsden, about three miles from South Shields. The station, which is to be primarily used for securing communication with passing warships, will be erected on the edge of the cliffs, which command a view north and south for miles along the coast.

It is stated in the *Engineer* that experiments with electric motive power are to be carried out on the State railways of Sweden, and that to cover the cost of the same the sum of 23,500*l.* has been granted. The experiments are to be begun at the beginning of next year.

Dr. Max Uhle, who for some months past has been carrying on archæological explorations on the coast of Peru for the department of anthropology of the University of California, has, says *Science*, made new excavations at Ancon, in several parts of the so-called necropolis, with the view of determining the relative ages of the cultures represented by the different kinds of mummies and objects. After abundant material for this purpose had been obtained, excavations were made a short distance south of Ancon. Here, in a hitherto unsuspected deposit free from mummies, remains of an early culture distinct in character from any other in Peru were found. After completing his investigations at this spot, Dr. Uhle proceeded northward along the coast towards Supe or beyond.

M. Doumergue, the French Colonial Minister, has just sent, as a circular letter addressed to the governors of the different French colonies, a note drawn up by the Minister of Public Instruction pointing out the special interest attached to the study of the properties of radio-active substances. The governors are invited to undertake inquiries with a view to the discovery in the French colonies of mineral deposits containing radium. It is hoped that the governors will be able to secure the interested assistance of travellers and engineers, and in this way succeed in finding such mineral veins.

The Port Erin Biological Station has been more fully occupied by students during 1904 than in any previous season. Thirty-two workers have occupied tables since Easter, and at times the accommodation and resources of the institution have been severely taxed. The aquarium attached to the institution is becoming increasingly popular with the public. On one day last week (the record so far) 486 visitors were admitted.

Wireless telegraphy is now being turned to practical use for weather forecasting, and if advance is to be made in our knowledge of the law of storms, it is probably in this

direction that we must look. The *Daily Telegraph* has made the first venture in the direction, and its enterprise promises success in the future in affording information of the approach of bad weather. Disturbances are always traversing the Atlantic, and they follow a course from W. to E., or perhaps more often from S.W. to N.E. These storm areas exert a considerable influence on our weather, and if in the summer months they do not actually occasion gales of any strength they are the cause of the rains and unsettled weather which we experience. In the winter, when our coasts are often swept by severe gales, wireless telegraphy will probably be of considerable value in giving early intimation of the approach of storms, and as Marconi's system is improved, and the messages can be sent at greater distances from our shores, the advantage will be much enhanced. The Meteorological Council was some time since in correspondence with Lloyd's with respect to taking advantage of wireless telegraphy, but up to the present it has not been found possible to conclude any arrangements.

According to the *Lancet*, a paper was recently read before the Paris Academy of Medicine by MM. Raymond and Zimmer on the results of the application of a tube of radium containing five cubic centimetres to various patients suffering from nervous affections. In hysterical cases the results were *nil*, and the same was the case in musculo-spiral paralysis and acute facial neuralgia. Very remarkable results, however, were obtained as regards the painful phenomena of tabes. Peripheral pains were rapidly and completely relieved, and in several grave instances of gastric crisis great relief was obtained. These results induced the observers to try the effects of X-rays, and they consider that they met with great encouragement. These results are to be communicated at some future meeting of the academy.

We have received from Messrs. Brewster, Smith and Co. the following pieces of apparatus, which will be found exceedingly useful by workers in chemical laboratories:—A self-lighting Bunsen burner for lecture table use, in which a two-way cock first directs a stream of gas on some black platinum, which, becoming heated, raises the temperature of some fine platinum wires sufficiently for these to ignite the gas from the burner itself. A burette holder with a new form of screw-clamping arrangement which is easily and quickly adjusted, and is a decided improvement on the older forms. A small turbine motor, which may be worked from the usual high-pressure water supply at from 2000 to 4000 revolutions per minute, will be found very efficient in stirring and agitating operations. A circular wire which may be adjusted by a screw to the desired size acts very effectively in fastening a connecting tube on to a high-pressure water tap. An improved cheap form of Ramsay burner, with two forks for supporting the combustion tube at various heights above the burner, gives a very uniform flame along its entire length.

According to some experiments on the formation of ozone at high temperatures by Mr. J. K. Clement, published in the *Annalen der Physik*, vol. xiv. p. 334, no trace of ozone is formed when pure oxygen is passed over the conducting substance of a Nernst lamp electrically heated to a temperature of 2000°–3000° C. When a trace of nitrogen is present, however, the issuing oxygen liberates iodine from potassium iodide solution, and the author believes that most of the recorded observations of ozone formation at high temperatures are in reality due to the formation of small quantities of oxides of nitrogen.

"The Geology of the Country around Kingsbridge and Salcombe" is the title of a memoir issued by the Geological Survey in explanation of the new series geological maps 355 and 356. In it the author, Mr. W. A. E. Ussher, has fully described the rocks of this difficult area. In the northern part there is no doubt about the Devonian age of the slates and grits, which are grouped with the Dartmouth slates and the Meadfoot and Looe beds. In the southern part of the area there is a tract of highly altered sedimentary and basic rocks, of mica schists and quartz schists, together with green or hornblende-epidote schists. Much controversy has arisen concerning the age of these metamorphic rocks, and although the author appears inclined to regard them as altered Devonian, he has refrained from expressing any definite opinion with regard to them. His careful and detailed record of facts will greatly aid further research. There are brief descriptions of the New Red rocks of Thurlestone and Slapton, and of the Pleistocene and recent deposits.

Dr. J. A. Udden contributes an essay on the geology of the Shafter Silver Mine district, in Presidio County, Texas (*Bull.* Univ. Texas, No. 24). The district is composed of Carboniferous with possibly Permian rocks and Lower Cretaceous strata, the whole being invaded by intrusive bosses, dykes, and sheets of various igneous rocks including granite, diorite, andesite, and rhyolite, while extensive lava flows have covered about one-third of the land. The mineral deposits, comprising argentiferous galena, &c., occur in the Cibolo limestone, which is probably of Permo-Carboniferous age, and the Shafter Mine, the only successful silver mine in the State, has been profitably worked for nearly twenty years. In the present report attention is mainly directed to the Carboniferous and Cretaceous strata and their fossils, of which detailed records are given.

In reference to the paragraph in our issue of July 28 with regard to recent captures in England of examples of the striped hawk-moth (*Deilephila livornica*), Mr. F. H. Perry Coste writes to us from Polperro, Cornwall, stating that one of these insects was captured near that village on August 1. Its wings were so rigid that good setting was impossible, and this leads the writer to believe that, like all British members of the species, it was a migrant from the Continent. Our correspondent would be glad to hear whether any of the other recently taken specimens were in the same condition, and whether they were captured near the shore.

A remarkable instance of protective resemblance is described by Mr. L. J. Cole in a paper on pycnogonid arachnida published in vol. xxxi. (pp. 315–328) of the *Proceedings* of the Boston Natural History Society. The pycnogonids in general are long-bodied, long-limbed, spider-like creatures, somewhat recalling the stick insects in their fantastic contour. The form in question (*Anoplodactylus insignis bermudensis*) has this irregular bodily contour specially developed, and is further remarkable for its coloration of mingled pink and yellow. It thus corresponds very closely, both in form and colour, with a hydroid zoophyte (*Obelia marginata*) of common occurrence in the Bermuda sea, among the branches of which it lives. A coloured plate illustrates the striking resemblance between the two organisms.

The *Irish Naturalist* for August contains two botanical papers of considerable interest, the one, by the Rev. H. W. Lett, recording a new species of liverwort (*Adelanthus dugortiensis*) from Dugort, in the Island of Achill, and the

other, by Mr. C. Reid, announcing the discovery in the "elk-marl" of Lough Gur of remains of the submerged flowering plant *Naias marina*. The new liverwort, curiously enough, appears to be very similar to a species from Tierra del Fuego. The Naias, we may remind our readers, is now found living only in one spot in Great Britain, namely, Hickling Broad, but has been found fossil in several localities, although it was hitherto totally unknown in Ireland.

SEVERAL pamphlets dealing with forestry problems have been received from the United States Department of Agriculture. Discussing the future supply of railroad ties, Mr. H. von Schrenck, in a *Bulletin*, shows that timber of inferior quality is rendered as durable as that of a better quality by treatment with suitable preservative substances. A recent process, which is still in the experimental stage, makes use of a strong sugar solution in which the timber is boiled. With the adoption of softer timber, the method of fastening the rails requires consideration, and the respective forms of spikes, plates, and dowels are contrasted. In a *Bulletin* on the planting of white pine, Mr. H. B. Kempton compares the results obtained on four different woodlots, from which it is concluded that the expense of laying out a pure white pine plantation is considerable, but this may be reduced by planting less expensive seedlings, such as sugar maple, between, and these are cut down when thinning is required.

"A CRITICAL Revision of the Genus Eucalyptus" is the title of a memoir by Mr. J. H. Maiden, director of the Sydney Botanic Gardens, which has reached the fourth part. Two species, *Eucalyptus incrassata* and *Eucalyptus foecunda*, with varieties, are described and figured in a number of plates.

THE extension section of the Manchester Microscopical Society has just issued an attractive list of popular science lectures (fifty-four in all) which have been arranged for delivery by its members during the coming winter. The object of the scheme is to bring scientific knowledge, in a popular form, before societies which are unable to pay large fees to professional lecturers, the work of lecturing and demonstrating being gratuitous on the part of the members.

THE Department of the Interior of Canada has recently issued a "Dictionary of Altitudes in the Dominion of Canada," by James White, the work being a supplement to that author's "Altitudes in Canada." The arrangement is alphabetical, by provinces and territories, and the volume should be of service to engineers, surveyors, and others who wish to know the altitude of any place in the dominion.

VOL. i. of the second series of the *Proceedings* of the London Mathematical Society, which has just been published by Mr. F. Hodgson, of Farringdon Street, contains obituary notices of Profs. L. Cremona, G. Salmon, J. Willard Gibbs, and Mr. G. H. Stuart, in addition to the papers read before the society from January, 1903, to February, 1904.

THE volume for 1903 of the *Journal and Proceedings* of the Royal Society of New South Wales has just reached us. It is issued in this country by George Robertson and Co., of 17 Warwick Square, E.C.

WE have received a copy of a catalogue (published by R. . Brothers, Melbourne) of the fine collection of eggs and nests of Australian birds in the possession of Mr. D. le Souëf, director of the Melbourne Zoological Gardens.

OUR ASTRONOMICAL COLUMN.

THE RETURN OF TEMPEL'S SECOND (1873) COMET.—The comet Tempel$_2$ (1873), which has a period of about 5·28 years, made its last perihelion passage on July 28, 1899, and should, therefore, reappear during the later months of the present year. Although this object will be but of feeble intensity throughout the apparition, it should certainly be observable, therefore M. J. Coniel, of the Paris Bureau des Longitudes, has calculated a daily ephemeris for it from the following elements, which were computed by Mr. Schulof. This ephemeris, an extract from which is given below, covers the period July 29—October 25, and is published in No. 3962 of the *Astronomische Nachrichten*.

Epoch 1904 October 30·0 M.T Paris.

$$
\begin{aligned}
M &= 357^\circ\ 51'\ 49'' \\
\omega &= 185\ 44\ 39 \\
\Omega &= 120\ 59\ 52 \\
i &= 12\ 38\ 55 \\
\varphi &= 32\ 50\ 3\cdot7 \\
\mu &= 672''\cdot175 \\
\log a &= 0\cdot41868
\end{aligned}
\quad \left.\begin{matrix} \\ \\ \\ \end{matrix}\right\} 1904\cdot0
$$

In computing these elements the perturbations of Jupiter and Saturn have been taken into account.

Ephemeris 12h. (M.T. Paris).

1904	α (app.) h. m. s.	δ (app.) ° ′ ″	log Δ
Aug. 17	14 23 45	−4 9 10	0·2242
,, 21	14 31 13	−5 17 34	0·2268
,, 25	14 39 4	−6 26 33	0·2292
,, 29	14 47 17	−7 35 56	0·2315
Sept. 2	14 55 53	−8 45 31	0·2336
,, 6	15 4 51	−9 55 4	0·2356

SPECTRA OF NEPTUNE AND URANUS.—The results of a photographic study of the spectra of Neptune and Uranus are given in No. 13 of the Lowell Observatory *Bulletins* by Mr. V. M. Slipher, reproductions of the photographs being given on an accompanying plate.

The spectrogram of Neptune extends from λ 4300 to D, and is compared with that of the solar type star β Geminorum. There is an apparent brightening, in the planetary spectrum, on the more refrangible side of *b* which seems to indicate intrinsic emission, but may be due to the contrast afforded by two strong absorption bands. Hβ is stronger in the Neptunian spectrum, and one photograph shows Hγ stronger, thereby indicating the presence of free hydrogen in the planet's atmosphere.

The spectrum of Uranus from F to λ 350 exhibits no departure from the normal solar spectrum, but on one photograph there is apparently a line in the position of D_3, indicating, if real, the presence of helium.

A comparison of the two spectra shows that although free hydrogen is present, in the atmosphere of Uranus it is not so abundant as in that of the outer planet. Three bands situated at λ 510, λ 543, and λ 577, respectively, are also stronger in the spectrum of the latter, thereby indicating that the atmosphere of Neptune is much more extensive than that of Uranus. The origins of these bands are at present unknown, unless the second and third are due to water-vapour, and Mr. Slipher suggests that they may be due to gases lighter than, but similar to, hydrogen and helium, which have not been recorded in stellar spectra because the temperature conditions in stars are, probably, unfavourably high.

THE VARIABLE RADIAL VELOCITY OF δ ORIONIS.—In a recent paper, Prof. Hartmann pointed out that the value which he obtained for the period of the "oscillations" of δ Orionis did not agree with those previously published by M. Deslandres.

The latter observer now shows, in No. 3963 of the *Astronomische Nachrichten*, that although the results are divergent the observations are confirmatory, for his result was based on very few observations, and is exactly one-third of the value obtained by Prof. Hartmann, the numbers being 1·92 and 5·73 (days) respectively. Prof. Pickering pointed out some time ago that periods of variable radial velocity which are derived from few observations are

likely to produce acceptable values, which may, however, be multiples or submultiples of the true values.

The intensity of the Meudon spectrograms about the region λ 393 is not sufficient to confirm, or refute, the observation of Prof. Hartmann that the "K" (calcium) line does not appear to share in the periodic displacements of the other lines in the spectrum.

The Solar Surface during 1903.—The annual report of the observations of solar phenomena made at the Lyons Observatory during 1903 appears in the August number of the *Bulletin de la Société astronomique de France*, wherein M. J. Guillaume gives comparative tables showing the numbers, areas, and distribution of spots and faculæ for the years 1900–1903 inclusive.

Of the 260 observing days in 1903 there were only thirty-eight on which "no spots" was recorded. Both the numbers and areas of spots show a marked increase on the previous year, the figures being 1902, 33 and 1785 millionths, and 1903, 115 and 8440 millionths. The mean latitude, for both hemispheres, during 1903 was 19°·3, in place of 15°·9 and 21°·2 for 1901 and 1902 respectively.

The groups of faculæ were fewer in number during 1903 than in 1902 (324 and 363 respectively), but their total area was a little more than twice as great (204·1 and 97·6 thousandths respectively), whilst their mean latitude was 27°·8, as compared with 38°·8 in 1902, and 35°·8 in 1901.

The preponderance of spots in the northern hemisphere remarked in 1901 and 1902 changed over to the southern hemisphere in 1903, the total areas during last year being S. 5071 millionths, N. 3369 millionths.

From the tables showing their distribution in latitude and longitude, one sees that the greatest augmentations of both spots and faculæ, in each hemisphere, took place in the same zones.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—Dr. Wm. Osler, F.R.S., has, with the King's approval, been appointed regius professor of medicine in succession to Sir John Burdon Sanderson, Bart., F.R.S. Prof. Osler has, since 1889, filled the chair of the principles and practice of medicine at Johns Hopkins University, Baltimore.

Cambridge.—In connection with the visit of the British Association, the degree of Doctor of Science, *honoris causa*, will on August 22 be conferred on the following:—J. O. Backlund, director of the Pulkova Observatory; Prof. H. Becquerel, Paris; Prof. J. W. Brühl, Heidelberg; Prof. A. Engler, Berlin; Prof. P. H. von Groth, Munich; P. Kabbadias, Athens; Prof. A. Kossel, Heidelberg; Prof. H. F. Osborn, New York; N. G. Pierson, Amsterdam; Prof. V. Volterra, Rome; Sir David Gill, K.C.B., F.R.S.; A. W. Howitt, the Australian anthropologist; Sir Norman Lockyer, K.C.B., F.R.S.; Major P. A. MacMahon, F.R.S.; Sir W. Ramsay, K.C.B., F.R.S.; Prof. A. Schuster, F.R.S.; Sir W. T. Thiselton-Dyer, K.C.M.G., F.R.S.

The first list of successful candidates for the university diploma in tropical medicine and hygiene has just been issued by the examiners (Sir P. Manson, Major Ross, and Dr. Nuttall). It includes the following:—A. R. Cleveland, A. R. J. Douglas, G. Elliott, P. N. Gerrard, C. M. Heanley, J. C. B. Statham, C. A. Suvoong, and J. C. Thompson.

Mr. S. A. McDowall, Trinity, has been appointed assistant to the superintendent of the Museum of Zoology (Dr. S. F. Harmer).

Dr. Albert S. Grünbaum, lecturer in experimental medicine at the University of Liverpool, and director of cancer research at Liverpool, has been appointed professor of pathology and bacteriology in the University of Leeds in the place of Prof. Trevelyan, who is retiring. Dr. George Wilson has been appointed to the newly created lectureship in civil engineering in the same university.

The syllabus for 1904–5 of the Redruth School of Mines shows that a successful local effort is being made to provide practical scientific training in mining to those engaged in this important Cornish industry. The main object of the School of Mines is to provide theoretical and practical instruction in mining and the allied subjects essential to the training of competent mining engineers. The training in practical mining is given at the Basset Mines and at other mines in the locality, under the general supervision of an instructor. The practical underground work includes the timbering of shafts and levels. Students are taught, in addition, the methods of prospecting for minerals in all positions, and are trained to detect favourable indications on the surface. They are shown by examples in the neighbourhood how to *costean* for lodes, and how to detect the effect of cross-courses and slides on the lodes. The differences between fissure veins, gash veins, and contact lodes are pointed out by examples; the manner in which the lodes are affected by passing through the different strata, and the effect the bearing of the lode has on its productiveness in certain districts. Studies are made of the maps of the neighbourhood, and opportunities afforded for examination of other mines now working, and for investigating, as far as possible, those that have been abandoned.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, July 25.—M. Mascart in the chair.—On a functional equation: Émile **Picard**.—Chemical and geological study of some springs in the north of Madagascar: Georges **Lemoine** and Paul **Lemoine**.—On some facts relating to the observation of variations in the lustre of phosphorescent sulphides under the action of *n*-rays or analogous phenomena: E. **Bichat**.—The academy was invited to send delegates to the second International Botanical Congress at Vienna, to be held from June 12 to 18, 1905.—On a relation between the minima and maxima of sun-spots: Alfred **Angot**.—On the singularities of the equation

$$y^1 = A_0 + A_1 y + A_2 y^2 + A_3 y^3:$$

Pierre **Boutroux**.—On the absorption of gases by wood charcoal at low temperatures: Sir James **Dewar**. The liquid air calorimeter is used to determine the heat liberated by the absorption of certain gases in charcoal, the volume absorbed being measured. With all gases except helium, the volume absorbed is greatly increased by low temperature. Absorption of gases with charcoal at low temperatures forms a good method of producing a vacuum.—On the nature of n and n_1 radiations, and on the radio-activity of the bodies which emit these radiations: J. **Becquerel**.—On the refraction of n- and n_1-rays: J. **Becquerel**.—On the contemplation in a dark room of surfaces feebly illuminated by certain special lights. The case of objects of linear form: F. P. **Le Roux**.—The phenomena of magnetic viscosity in soft industrial steels, and their influence on the methods of measurement: Raymond **Jouaust**.—Magnetic exploration of the Gulf of Padirac: E. **Mathias**.—On the earthquake of July 13, 1904, in the central Pyrenees: E. **Marchand**.—On the discharge of electricity in the air at the summit of the Eiffel Tower during the storm of July 24: A. B. **Chauveau**.—On the form taken by thallous iodide on being deposited from solution: D. **Gernez**.—On radio-active lead, radio-tellurium, and polonium: A. **Debierne**.—Action of zinc on the tungstates of sodium: L. A. **Hallopeau**.—On the acid pyrophosphate of silver: J. **Cavalier**.—On the composition of the homologues of Schweinfurt green: Georges **Viard**.—The heat of formation of the trisulphides of antimony: MM. **Guinchant** and **Chrétien**.—On polishing and connected scientific phenomena: F. **Osmond** and G. **Cartaud**.—On vinyldimethylacetic acid: E. E. **Blaise** and A. **Courtot**.—β-Oxyalkyl and β-oxyphenyl ethylene ketones. The action of hydroxylamine and phenylhydrazine: Ch. **Moureu** and M. **Brachin**.—The action of oxalacetic ether on aromatic aldehydes in the presence of β-naphthylamine: L. J. **Simon** and A. **Conduché**.—The action of acid chlorides on tertiary bases with an aromatic nucleus: V. **Auger**.—On the general arrangement of the nervous system in *Rissoa elata*, var. *oblonga* (Desmaret): G. **Quintaret**.—On the intracellular contents of the parenchyma of certain fruits: Wladimir **Tichomirow**.—On the anatomy of the tubers of *Euphorbia Intisy*: Marcel **Dubard** and René **Viguier**.—Contribution to the study of blight in tobacco leaves: MM. **Bouygues** and **Perreau**.—Researches on the

mechanism of respiratory combustion. The production of citric acid by *citromyces*: P. **Mazé** and A. **Perrier.**—On the law of Bravais and the reticular hypothesis: G. **Friedel.**—On the lode of heavy spar called "la Chandelette," near Villefort: Marcel **Guédras.**—On the evolution of the zone of sub-Carpathian depressions in Roumania: E. **de Martonne.**—The relation between seismic phenomena and the geological age of a chain or region: M. de Montessus **de Ballore.**—On the property possessed by certain portions of the human body of continually giving out a ponderable emanation: Julien **Meyer.**—New facts on the *rôle* of the nervous system in the function of the heart: Jean **Dogiel** and K. **Arkanguelsky.**—Toxic substances extracted from the eggs of the tortoise and of the hen: Gustave **Loisel.**—Researches on the poison of bees: C. **Phisalix.**—On the bactericidal properties of the secretions of parasitic worms: L. **Jammes** and H. **Mandoul.**—On the infectious nature of the anæmia of the horse: MM. **Vallée** and **Carré.**

August 8.—M. Mascart in the chair.—On the changes of curvature exhibited by the air bubble in spirit levels, under the influence of temperature variations: G. **Bigourdan.** A particular level, used on a telescope mounting, showed considerable variations in its constant with temperature. This was traced to the effect of the expansion of the metallic tube in which it was mounted, and the conclusion is drawn that for work of precision it is necessary to reject this form of mounting, and to use instead a nickel steel possessing an expansion equal to that of the glass.—The general equations of motion of sheets of water infiltrated through the soil: J. **Boussinesq.** A continuation of a previous paper on the same subject. Certain restrictions laid down in the first note are removed, and the results worked out to a higher degree of approximation.—On some results recently obtained by metrophotography: A. **Laussedat.** Some additional results obtained with the apparatus of Pulfrich by the method of parallaxes. In the Tyrol, two photographs, with a base of 254 metres, have proved sufficient to construct the greater part of a map of the district on the scale of 1/25,000, including mountains of a height of more than 3000 metres, and 8 kilometres distance from the base. The apparatus has also been successfully applied in Canada.—On the use of a movable reference tetrahedron in the geometry of Cayley: A. **Demoulin.**—On groups of the order p^m, of which all the subgroups p^{m-2} are Abelian: M. **Potron.**—On a theorem of M. Borel in the theory of integral functions: M. **Rémoundos.**—On the loss of electricity in the air observed at the summit of the Eiffel Tower during the storm of August 4: A. B. **Chauveau.**—The theory of dilute solutions, based on the law of van 't Hoff: É. **Ariès.**—On the permanence of crystalline forms in crystals: F. **Osmond** and G. **Cartaud.**—New researches on vanadium steels: Léon **Guillet.** Normal vanadium steels are not more fragile than ordinary steels containing the same percentage of carbon. They are very sensitive to thermal and mechanical treatment.—On some derivatives of pentabasic phosphoric acid: P. **Lemoult.**—On dimethylpyroarsenic acid: E. **Baud.**—On the existence of alkaline rocks in Central Africa: Louis **Gentil.**

NEW SOUTH WALES.

Linnean Society, June 29.—Dr. T. Storie Dixson, president, in the chair.—Descriptions of Australian Microlepidoptera, xviii., Gelechiadæ: E. **Meyrick,** F.R.S. This family forms a smaller proportion of the Tineina in the Australian region than it does in Europe, amounting, perhaps, to about 12 per cent. of the whole. As, however, the species are often retired in habit, small, inconspicuous, and rather difficult to study, they have been much neglected, and may perhaps prove eventually to be more relatively numerous than they seem at present. Fortunately only seven species were known to Walker, others assigned by him to this family being wrongly attributed. Mr. O. Lower has in late years described some number; he has very kindly transmitted specimens of all these (frequently the actual types) for examination, so that the author has been able to ascertain positively their identity in all cases; this assistance has been most valuable. Much material in specimens and notes of localities has also been received from him, as well as from Mr. G. Lyell, the late Mr. G. Barnard, and other collectors whose records are duly acknowledged in their place. Altogether 274 species are here recorded, of which 207 are now described as new. Of this total, 85 species, or not much less than a third, are included in the endemic genus Protolechia, but no other strictly endemic genus attains any large size, though 40 out of the 55 genera are endemic, so far as is known.—A variable galactan bacterium: Dr. R. Greig **Smith.** A bacterium isolated from the tissues of a species of Strychnos grew on gelatin as brittle moruloid colonies which contained an insoluble gum. Cultivation at 30° C. caused the organism rapidly to lose the faculty of forming this insoluble gum. A soluble gum was produced instead, and the colonies in consequence became gummy and otherwise uncharacteristic. The gums from both forms of bacteria were galactans, and differed only in solubility.—The red string of the sugar-cane: Dr. R. Greig **Smith.** Instances of the vascular strings of the sugar-cane being coloured a deep red from the presence of a red gum in the large vessels have been recorded in connection with certain diseases, such as sereh, the sugar-cane disease of Massee, the pine-apple disease of the cane, and red smut (red rot), in all of which it has been denied that bacteria produce the gum. The cases of red string investigated by the author occurred in apparently healthy plants, and also in canes affected with gummosis. The gum was produced by *Bacillus pseudarabinus*, n.sp., and the crimson colour was imparted to it by a mould. The co-existence of the two is essential for the production of the colour in the vessels of the sugar-cane. Both organisms are described in detail. The gum gave the reactions for arabin, but as it hydrolysed to galactose only it was a galactan.

CONTENTS. PAGE

THURSDAY, AUGUST 25, 1904.

NATURAL HISTORY.

Catalogue of the Library of the British Museum (Natural History). Vol. ii. E—K. Pp. 501–1038. (London: Published by Order of the Trustees, 1904.) Price 20s.

Catalogus Mammalium, tam viventium quam fossilium, Quinquennale Supplementum. By E. L. Trouessart. Fasciculus i. Pp. iv+288. (Berlin: Friedländer and Son, 1904.) Price 12s.

Our Country's Animals and How to Know Them; a Guide to the Mammals, Reptiles, and Amphibians of Great Britain. By W. J. Gordon. Pp. viii+152. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1904.) Price 6s.

THOSE responsible for the preparation of the invaluable "Catalogue of the Library of the Natural History Museum" are to be congratulated on the comparatively short interval which has elapsed between the issue of the preceding volume and the appearance of the one before us. About half the works included in the library at the commencement of the undertaking are catalogued in the two volumes now before the public, so that two more volumes, with the addition of a supplement, ought to complete the work. Needless to say, the present volume is compiled on the lines of its predecessor. A feature to which we may direct attention is the printing of the entries in such a manner that they may, if required, be cut out so as to form a card catalogue, the names of authors being given in full with each entry. We venture to think, however, that it would have been better had a few copies been issued with the letterpress on one side only of the paper, so as to have been available for this purpose without the sacrifice of an extra copy. Another noticeable feature is the care with which the dates of publication of works issued in parts have been worked out—in many instances for the first time—whereby several amendments have been made in the commonly accepted dates of certain technical names. An instance of this is afforded in the case of the large series of French voyages entered on pages 606–608 under the heading of France, which contain in many cases original descriptions of species collected during the cruises in question. The bibliographical staff of the Natural History Museum deserves great credit for the accuracy and fulness of detail with which this work is compiled.

With Mr. Palmer's "Index Generum" (recently noticed in our columns) and Dr. Trouessart's work, when complete, the student ought to have little of which to complain in regard to facilities for reference to the literature of his subject. Not that such facilities were by any means uncalled for. During the last ten years or so the number of new generic, specific, and subspecific names proposed for mammals has been so great, and such sweeping changes (whether for better or worse we need not now pause to consider) in current nomenclature have been advocated, that, to use a colloquial expression, naturalists of a conservative type scarcely know where they are. It was, therefore, imperative that something should be done in the way of codifying, and that speedily. Dr. Trouessart, with characteristic energy, has stepped into the breach and supplied the want.

The second, and revised, edition of the author's well known "Catalogue" was published from 1897 to 1899, the last part containing an appendix. To include the additions and changes made since the latter date in an appendix would, however, have been almost a practical impossibility, and as an entirely new edition was considered out of the question, Dr. Trouessart has followed a kind of middle course by the compilation of the present "Supplement," of which the part before us contains the orders Primates, Chiroptera, Insectivora, and Carnivora. While every genus, species, and subspecies is entered, references to the original descriptions are given only in cases where the terms are new, or where they replace those previously in use; in other cases reference is merely made to the last edition of the "Catalogue." By this plan a vast amount of space is saved, without any inconvenience to the student—provided he has access to the original issue.

Dr. Trouessart professes to have brought his labours only down to January, 1903, but many names proposed later on in that year are entered. Nearly all recent proposed changes in nomenclature are adopted—even the transference from the squirrel-monkeys of the name Callithrix to the marmosets so long known as Hapale; but apparently the author will not accept pre-Linnean generic names, as he retains Trichechus for the walrus. Difference in spelling is considered insufficient to justify the use of the same term for two distinct species or groups.

Some idea of the magnitude of the task involved in the compilation of this supplement may be gleaned from the fact that, in the case of the Primates alone, the number of specific (exclusive of subspecific) names has been increased by thirty-five since the appearance of the last edition of the "Catalogue," while most of the genera have been the subjects of more or less important changes and revisions. As usual, Dr. Trouessart's work appears to be exceedingly accurate; as to its value to students, no words of ours are necessary. It is indispensable and unique.

We fear Mr. Gordon's little volume will give rise to a new "Irish grievance," for although Great Britain is alone mentioned on the title-page, the Irish stoat and the fossil vertebrates peculiar to the coal-fields of the sister island come within its scope. Neither is the title in another respect very happy, although we are fain to confess it would be difficult to find a single term to replace the word "animals" in the sense in which it is here employed. Like most other compilers of popular works of this nature, the author appears to be totally ignorant of the existence of that invaluable publication the "Zoological Record"; at all events, we are otherwise unable to account for his omission of any mention of the numerous subspecies of mammals now recognised by

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naturalists as peculiar to the British Islands, with the sole exception of *Mus sylvaticus wintoni*. One of the worst omissions of this nature is the absence of any reference to the marked distinctness of the British squirrel and its remarkable seasonal colour-changes. As regards nomenclature in general, we observe that while the author avoids such objectionable alliterations as *Vulpes vulpes* and *Lutra lutra*, he is in many respects—notably in the case of the bats—out of date.

In addition to existing types, the author also records extinct forms, but since the amount of descriptive matter allotted to these is very brief, the lists of genera and species are dismal and uninteresting. Nor are they free from error, Hyracotherium, for instance, being described as tapir-like, while Microchœrus is classed as an insectivore instead of as a lemur. Equally glaring are the errors in the list of fossil reptiles, where we find Ornithostoma among the crocodiles, the sauropod Bothriospondylus among the theropods, the theropod Palæosaurus in the sauropods, and many other errors of a similar type, in addition to numerous misprints.

The coloured illustrations, although not perhaps very artistic, are sufficient in most cases to enable the reader to identify the various species without difficulty, while the excellent glossary of technical terms should prove useful to the beginner. While welcoming this little volume as an honest attempt to popularise a knowledge of the British mammals and reptiles, we cannot but regret that the author did not seek specialist advice and assistance before going to press.

R. L.

PHILOSOPHY OF LIFE AND DEATH.

The Nature of Man: Studies in Optimistic Philosophy. By E. Metchnikoff. English Translation edited by P. Chalmers Mitchell, M.A., D.Sc. Pp. xviii+309. (London: W. Heinemann; New York: G. P. Putnam's Sons, 1903.) Price 12*s*. 6*d*.

PROF. METCHNIKOFF'S work is already known to many; it has been widely read in previous editions, and, now that it is offered in an English version, will become still more widely known. The great merits of the work have already been appreciated. The author is an acknowledged master of his subject, and no more fruitful source of valuable ideas could be imagined than a mind which combined with philosophical breadth and acumen an accurate and far-reaching knowledge of every grade of organism. One sees from the apt choice and effective use of examples how thoroughly the author has his materials at command.

If we might characterise with a word the central problem of the book, ethical would seem the term most appropriate. The key-words are harmony and disharmony; we ask sometimes, Why should we be moral? Prof. Metchnikoff's question is rather, Why do we need morality? The answer lies in the existence of disharmonies. The first part of the work deals with these disharmonies as a matter of scientific discovery; they are shown to exist in the structure of organisms throughout the vast scale of nature; not least do we find in man disharmonies of digestion, of reproduction, and of self-preservation; the whole discussion forms a chapter of extreme interest and importance. The second part reviews the attempts of religion and philosophy to account for or alleviate these disharmonies. The polemic is severe; religion especially is arraigned for failing in its own efforts and hindering those of science; belief in immortality is an illusion with which we soothe a mind conscious that it has been cheated of its due. Old age and death form the topic of greatest interest to the author. The principle underlying the third and closing section of the work is that no natural process should be productive of pain; death as the natural end of life should therefore be normally accompanied by a desire for the end; desire depends on physical conditions, and this harmony can only be produced if life is so far prolonged that the desire to live wanes with the physical strength. This, our author thinks, is a harmony which science can in time secure for us; the details must be left for the reader to discover; at any rate, he will find a topic of great interest excellently treated.

Prof. Metchnikoff's reputation in the scientific world is unique; he comes before us here as something more than a man of science, rather as a prophet, one might almost say, as a high priest. Faith, disillusioned, is to leave its old temples and take sanctuary in laboratories. If progress dictates this course, no prejudice should hinder it. Meanwhile the opposition of the second and third parts of this book affords an interesting view of the prospects. Take, for example, the contrast of the philosophic question and the scientific answer. The question propounded is, Can I hope for immortality? Science replies that the proper term of life is, say, 150 years. The spirit cries out to be saved from the prospect of annihilation; science replies that if you live properly you will some day want to die! Clearly one question is asked, but the answer is the answer of another and a different problem. The materialistic bias of a scientific position, accepted uncritically, seems to have left the refuted philosophy and the triumphant science in a kind of asymptotic relation. At the best it would seem that the theory cannot remove the mental disharmony which the realisation of finitude coexisting with the purpose to live must always produce. It is only in the more limited sphere that science succeeds in being optimistic, and the optimism of this book is conditioned upon our ability to regard the spiritual as a subordinate aspect of the material, a point that the disciple may delight to accept but the unbeliever desires to have demonstrated.

The translation of this book seems to have been carefully done, with only an occasional divergence from accuracy. Why have we three distinct spellings of Buddha (p. 120)? *cp.* Bhuddhism (p. 120), and Bouddha (p. 148). Meringitis (p. 132) requires correction, while the sentence "so there were only Tourgéneff . . . and me" (p. 121) might be improved in its grammar.

G. S. B.

OUR BOOKSHELF.

Warrington's Roman Remains. By Thos. May, F.E.I. Pp. 87. (Warrington: Mackie, 1904.) Price 5s. net.

ARCHÆOLOGISTS have long known that a Roman site existed near Wilderspool Brewery, close to the Mersey on the south side of Warrington. Discoveries have been made during the constructions of various canals, and remains have accumulated in Warrington Museum. Now a local antiquary, Mr. May, has attempted during the last eight or nine years to excavate a small portion of the site—some two or three acres out of an estimated total of thirty or thirty-five acres. In the volume before us he collects, revises, and illustrates various accounts of his work which he had previously published in scattered papers. The collection is a useful contribution to the local study of Roman remains. It has the merits and demerits of many books of the same kind. In his general attack on the problem of what Roman Warrington was, we think Mr. May has not succeeded. He calls it "a partly fortified industrial town" extending over a quarter of a mile on both sides of a Roman road; but his fortifications are puzzling, and his furnaces, smelting floors, &c., do not constitute an "industrial town" in any proper sense of that phrase. On the other hand, he records interesting minor discoveries in the way of pottery and small objects, and the traces noted by him of glass workers, iron workers, and potters are noteworthy, though it may be rash to call them "the earliest in Britain." The little volume is well illustrated, though printed on rather unpleasant paper.

The Experimental Bacterial Treatment of London Sewage. (London County Council.) By Prof. Frank Clowes, D.Sc., and A. C. Houston, M.B., D.Sc. Pp. xii+242. (London: P. S. King and Co.) Price 10s.

THIS report contains an account of the experiments carried out by the London County Council during the years 1902 and 1903. The main conclusions arrived at by Prof. Clowes in the first part (chemical and general) of the report are that coke is a suitable material for bacterial beds and does not disintegrate during use, that the bacterial effluent of settled sewage from such beds does not undergo offensive putrefaction and supports fish life, and that the use of chemicals is unnecessary when this mode of treatment is adopted. In the second part Dr. Houston deals with the bacteriological portion of the experimental work. His results seem to show that though the number of bacteria in the effluent from coke beds is less than in the corresponding crude sewage the reduction is not well marked, and while the bacterial effluent is chemically satisfactory, the bacteriological results are usually quite the reverse, because the microbes pass through the coke-beds. There seems to be small ground for belief that the typhoid bacillus would be destroyed in the beds; an important conclusion.

The report is copiously illustrated with diagrams and photomicrographs. R. T. HEWLETT.

Round the Coast. A Reading Book for Schools. By George F. Bosworth. Pp. viii+248. (London: George Routledge and Sons, Ltd., 1904.) Price 1s. 6d.

THESE short, miscellaneous reading lessons will serve to teach boys and girls many interesting facts about the geography and history of England. Numerous poetical pieces are included, and the maps and pictures much increase the book's attractiveness.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Synthesis of Radio-active Substance.

IN connection with the suggestive letter of Sir William Ramsay and Mr. Cooke, the following observation appears to be of some interest. My friend Prof. H. H. Dixon, in conjunction with Dr. Wigham, in the course of some experiments on the β and γ radiations of radium on bacteria used a platinum rod to cast a shadow on the culture, in order the better to estimate by contrast whether the rays had effected the culture or not. The platinum rod so used to intercept the rays was of cylindrical form and about 3 mm. in diameter. Prof. Dixon's and Dr. Wigham's observations are published in the *Proc.* R.D.S., and also in NATURE.

Happening at the time to be repeating some of Dr. Russell's well known experiments on the influence of metals on photographic plates, I used this rod, among other specimens of metallic elements, to observe their photographic activity. This was about thirty days after Dr. Dixon had made his experiments. I was surprised to find that the rod, after resting twenty-four hours upon an instantaneous plate, had not only affected the plate, but had also produced all the appearance of intense solarisation, darkening the plate in its neighbourhood, but clearing it completely along the line of contact. The negative is still in my possession.

In this experiment the only action upon the plate was from the γ and β rays, the radium (5 mgrs.) being enclosed in a sealed glass tube.

In a subsequent experiment, a copper coin kept enclosed along with some radium contained in an aluminium button, when tested photographically, gave no specially marked result.

It would be desirable in experiments of the kind described by Sir William Ramsay and Mr. Cooke that α rays should in some cases be permitted to exert their influence. If Dr. Harold Wilson's suggestion as to the nature of these radiations is correct, it may well be that these positive ions may take part in synthetic effects.

I have already ventured to suggest the possibility of the synthetic origin of radium, partly in answer to a difficulty I have not seen discussed, *i.e.* what becomes of radiated ions when these are absorbed by atoms. J. JOLY.

Valencia, Co. Kerry, August 14.

Action of Metals on Photographic Plates.

IN the course of the experiments referred to above, as to the nature of the Russell effect, I found that metals (pure mercury and polished speculum metal) placed in contact with a rapid plate submerged under absolute alcohol, and the whole enclosed in an air-tight desiccator over calcium chloride, afforded the photographic marks on subsequent development just as vigorously as if obtained in ordinary moist air. Is not this experiment sufficient to show that Dr. Russell's explanation, which refers these marks to the formation of hydrogen peroxide, cannot be correct? Ought we not rather to seek the explanation in the ionising properties of metals indicated by other observations?

August 14. J. JOLY.

"The Primrose and Darwinism."

YOUR readers may remember a book published under the above title some few years ago, and my apology for bringing up the subject again is the delight with which many reviewers hailed it as totally destructive of Darwin's theory of the fertilisation of the primrose. Whilst viewing with distrust the entirely unscientific method displayed in the book, I considered a useful purpose might be served by repeating some of Darwin's primrose experiments under different conditions.

Plants of primroses were therefore potted up and forced in a hothouse in February, 1904, and crossed and self-

fertilised, and experiments of a similar nature carried out on wild plants *in situ* in June, 1903, and also June, 1904.

In no case could I get a flower to fertilise itself, though crossed flowers produced abundant seed under both conditions. A correspondent in Edinburgh, experimenting upon primroses for quite another purpose, confirms my experience in this matter.

The author of the above-mentioned work has in my opinion fallen into the common error of deducing a function from a structure without recourse to the experimental method, a mode of procedure which has, I believe, led him into grave error. E. A. Bunyard.

The Bungalow, Allington, Maidstone, August 8.

An Optical Phenomenon.

Mr. Hillig's letter in Nature of August 18 (p. 366) reminds me of a somewhat similar phenomenon which I observed last May when using a rotating cubical mirror and sensitive flame.

When the mirror was rotated by hand at moderate speed the upper and lower edges of the band of light seen in the mirror presented exactly the appearance of a faint spectrum, red being outside and pale green and blue inside. The central portion of the band was colourless.

The appearance was most distinct when the flame was influenced by a sound.

I repeated the experiment to-day with the same result.

George W. Walker.

Physical Laboratory, The University, Glasgow, August 19.

Traction of Carriages.

In further answer to your correspondent, p. 270, in passing along a road the wheels of a carriage encounter many small obstacles and inequalities over which they have to rise. In doing so the centre of gravity of the load (which is always higher than the axles) is raised to a greater vertical height when the axles are far apart than when they are close together. The work done in the former case is, therefore, greater than in the latter, by an amount the magnitude of which is proportional to the difference between the versed sines of the angles through which the carriage is tilted in each case respectively. The same argument applies in regard to lateral oscillations of the centre of gravity with the corollary that the narrower the gauge the more easily is the carriage propelled or drawn.

There may also be some question as to the influence of the different rates of retardation and acceleration of the centre of gravity in each case.

Cardiff, August 1. W. Galloway.

Indian Rhynchota.

In the issue of Nature of August 11 (p. 341) there appeared a notice of my second volume on "Indian Rhynchota" (Blanford series), in which I read, "the two last families of the Gymnocerata (Hebridæ and Hydrometridæ) are left over to be included with the Cryptocerata" in the third volume.

This is an error. They have already appeared in their proper location, vol. ii. pp. 167 and 168–192.

W. L. Distant.

Steine House, Selhurst Road, South Norwood, S.E.

[The reviewer regrets the oversight which Mr. Distant has pointed out.—Ed.]

The Earliest Mention of Hydrodictyon.

Twan Ching-Shih (*ob.* 863), in his "Yû-yang-tsah-tsu," Japanese edition, 1697, tom. xix., fol. 12, *a*, writes:—

"The *Shwui-mung-tsiau* (literally, Water-net-alga) grew in Kun-ming-chi [an artificial lake formed by the order] of the Emperor Wu-ti of the Han dynasty [reigned 140–87 B.C.]. Its branches, spreading sidewise, now come out of water slantly. It was eight to nine feet long and so closely resembling the meshes of a net that the ducks could not come out of it when got therein. Hence the name."

This is likely to be an exaggerated Chinese account of the now well known water-net (***Hydrodictyon utriculatum***, Roth.). In this part, when a paddy-field has its water drained off, we meet frequently this alga, "spreading sidewise, now coming out of the remaining water slantly," although such a gigantic dimension as "eight to nine feet" is totally out of the question. Perhaps this is the earliest record of the alga. Kumagusu Minakata.

Mount Nachi, Kii, Japan.

MARCONI WEATHER TELEGRAMS.

Meteorologists have for a long time felt that they have practically come to the limit of their resources in the matter of weather forecasting, so far as the weather changes in the British Isles are concerned, except, perhaps, if finance allowed that telegrams might be received at a later hour than 6 p.m. This later information might avoid the possibility of a storm system advancing towards our western coasts slipping in unobserved between the present hours of observation, 6 p.m. and 8 a.m., without proper intimation of its approach by the fall of the barometer and the backing of the wind being duly notified. Occasionally some of our worst storms spread over us in this way, and the forecaster, who has been unable to foresee the incoming disturbance by aid of the 6 p.m. weather telegrams, finds to his dismay when viewing the next morning's weather information that the full violence of the storm is upon us, for which no storm warnings have been issued. In this way, from time to time, the central area of an important storm is well over the United Kingdom before our Weather Office is aware of its existence.

Wireless telegraphy promises to supply the missing link in the connection of our shore weather system with that over the ocean to the westward of us, and the present praiseworthy effort on the part of the *Daily Telegraph* seems likely to prove, even now with the restricted powers of the Marconi system, that useful information can be obtained. The messages at present are transmitted only about 100 miles from land, but the scheme which has been most ably inaugurated has provided that, in addition to the latest weather report when approaching our shores, there should also be a report of the weather experienced some time previous, so that it is not merely an isolated observation with which we have to deal, but a fair knowledge of the weather from about mid-Atlantic is secured. This information is at times supplied by two or three vessels, so that synchronous observations are obtainable, and it will easily be understood that with further development of the system an approximate synoptic and synchronous map of the Atlantic may be produced. The storm areas very frequently follow a course almost due east when approaching our islands, but often when in fair proximity to our coasts they trend to the north-east, and any help in enabling a true estimate to be formed of the storm's path will be of the greatest possible advantage to the forecaster. Information with settled conditions will be of great value, since it is expected that forecasts should show with some certainty the advent or continuance of settled weather. When an area of high barometer readings is situated to the westward of our shores, and is willing to give way, it affords an indication of the early approach of storm systems, with disturbed weather, from the open ocean, while if the anticyclone maintains its ground the approaching disturbance will be fended off and made to follow a course more to the north-east, and may be taken altogether beyond the limits of the United Kingdom.

For some time past the Meteorological Office has had in hand the charting of the weather over the North

Atlantic, for which purpose it obtains observations of wind, weather, barometer, and temperature of air and sea from observers in the Mercantile Marine who are willing to assist in the advancement of our knowledge of the weather in this way, and a daily chart is prepared giving a picture of the weather over the Atlantic and for the adjacent continents of Europe and America for 8 o'clock each morning. A study of these is helpful to the furtherance of our better understanding of meteorology and its complicated problems, but necessarily these charts picture only what is past, although they afford an explanation of success or failure in forecasting, and often show why an unexpected and altogether unlooked for change of weather has occurred. These charts are prepared as closely as possible to date of occurrence. When the Meteorological Office has the advantage of receiving messages by the wireless telegraphy, both from outgoing and incoming Atlantic liners, they will unmistakably possess a power which has long been known to be wanting. The *Daily Telegraph* has taken the initiative, and it is to be hoped that the arrangements which the Meteorological Office has already been endeavouring to make with Lloyd's for fuller information will shortly meet with that success which it deserves, for the advancement of science and for the public benefit.

With the further development of Marconi's system there seems every reason to hope that we in England may be placed much on the same footing as Denmark, for example, is now, in full possession of the knowledge of what is going on for several hundred miles to the westward of the base of operations, to the immense gain of the forecaster for the country concerned. Knowing what is going on over the Atlantic to the westward of us would not only secure greater accuracy of forecast, but the time limit could probably be extended from twenty-four hours, as at present, to, say, forty-eight hours at least.

PROF. J. D. EVERETT, F.R.S.

THE death of Prof. Everett has removed a familiar figure from the ranks of English physicists. The news of his death came as a shock to his many friends and others acquainted with his great vitality and his intellectual activity, which seemed to remain quite unimpaired by advancing years. Some seven years ago he retired from teaching work in Queen's College, Belfast, where, for upwards of thirty years, he had occupied the chair of natural philosophy. Since that time he resided in London, where he took an active part in the proceedings of scientific societies, specially of the Physical Society, of which he was a vice-president.

Dr. Everett's name has been familiar to many generations of students of physics through his admirable translation of Deschanel's treatise, which has long served as a standard text-book. Many editions of this were called for; and as each fresh edition was carefully brought up to date by additions and alterations, the book became ultimately almost entirely a new work. Another very important service to physical science was rendered by the publication of Prof. Everett's book on the C.G.S. system of units. This very useful compendium made its first appearance at the time when the question of fixing the practical electrical units was being discussed, and proved of material service in that connection. It gives not only clear and precise definitions of fundamental quantities, but also numerical data carefully selected and compiled.

Dr. Everett's earliest original work consisted of an experimental determination of the elastic constants of certain solids. Subsequently he confined himself to work on his text-books and to theoretical investigations. His published papers, which appeared for the most part in the *Philosophical Magazine* or in the pages of this Journal, show by their subjects the wide range of his interests. Thus recent papers treat of the theory of combination tones, Hering's colour-theory, dynamical illustrations of optics, the theory of rent, the properties of certain linkages, and the mathematics of bees' cells. His last paper, elucidating a point in connection with Osborne Reynolds's theory of the universe, appeared only a month or so ago. He served for many years as recorder of the British Association Committee for Investigation of Underground Temperatures, and did much valuable work in drawing up the annual reports.

Dr. Everett's energy and ingenuity found outlets also in directions not purely scientific. He was the inventor of a system of shorthand which has found many adherents. He devised an extended form of slide-rule, ingeniously arranged on sheets of cardboard. An early and enthusiastic votary of cycling, he was much interested in cycle construction, and was an active member of the Cyclists' Touring Club. A man of great kindliness and geniality, he will be missed in many circles. His pupils will remember him always with gratitude and affection.

THE BRITISH ASSOCIATION AT CAMBRIDGE.

THE meeting of the British Association at Cambridge concluded yesterday. The meeting has been in every way a success. In all the sectional sessions large attendances were secured, and the general and social meetings were all successfully carried through and greatly appreciated. In regard to numbers of members, the Cambridge meeting was the largest since the Liverpool meeting of 1896. At this meeting there were 3181 members and associates, at the meeting just concluded at Cambridge the number of members and associates was 2783. It is interesting to compare the numbers of other large meetings with the one just held. The largest number of members and associates that have attended a meeting was at Manchester in 1887, when the number was 3838. At Newcastle in 1863 there were 3335, at Liverpool in 1870 there were 2878, and at Bath in 1864 the number was 2802. These meetings are the only ones which have had a larger attendance than that at Cambridge, and it is interesting to observe that in all these cases the meeting has been in a large city where the number of resident members and associates naturally would be very much larger than in a comparatively small town such as Cambridge. Compared with recent years the numbers show a large increase. Last year in Southport 1754 attended the Association, in Belfast the year before there were 1620, and in Glasgow in 1901 there were 1912. Comparing the meeting just concluded with the three former meetings held in Cambridge we find a great increase in numbers. In 1833 there were 900 members and associates, in 1845 there were 1079, and in 1862, 1161.

The cause of the great popularity of the Cambridge meeting this year is undoubtedly to be found in the great growth and expansion in scientific work at the University during the last twenty-five years. The work done at Cambridge in the last quarter of the nineteenth century in all branches of science has made Cambridge a great centre of attraction for scientific men the world over. At this year's meeting there were present 121 foreign members. Amongst these there was a large number of physicists attracted by

the Cavendish Laboratory, and the interest attaching to it owing to the great succession of Profs. Maxwell, Rayleigh, and J. J. Thomson. The school of research built up by J. J. Thomson has done so much in investigating, especially the new field opened in physics in the last few years, that "the Cavendish" has attracted physicists from all parts of the world. In other branches of science also, in chemistry, in physiology, in zoology, in engineering, in anthropology, in fact, in almost all departments, the new spirit of research, which has permeated Cambridge, and the men who have done so much to put Cambridge in the forefront of progress in scientific discovery, has made this University a great attraction to all those who have the advance of science at heart.

The large number of serious students attending all the sectional meetings this year has been an encouraging sign, showing that the increase in numbers has not been due merely to the camp followers of science, but to those who are really interested, and who wish to make of the British Association more than an annual week of excursions and garden parties. There have been, of course, a large number of members and associates who have not joined the Association for any other purpose than a week of pleasant social meeting, and in some ways it seems a pity that there should be such a number who do not really add to the usefulness of the meeting.

This is not the place for any detailed account of sectional meetings, full accounts of these will appear in other columns of NATURE. Here all that is necessary is to give a short account of the general meetings and lectures. With regard to the entertainment of the Association there has been expressed by visitors to Cambridge nothing but satisfaction. The reception of the members of the Association by the President in Trinity College was a most successful meeting. Over 2000 members attended and were received by Mr. Balfour in the hall. The grounds and courts were illuminated. The President's address was delivered in the Corn Exchange, which was decorated for the occasion, and above 2000 members were present. At Peterhouse about 600 of the members were entertained by invitation of the Master and Fellows. The grounds of the college were illuminated, and a very pleasant evening was spent.

On Friday evening a reception was held at the invitation of the Cambridge Philosophical Society in the combination room and hall of St. John's College. Dr. Baker, the President of the Society, presided. This reception, which was limited in number, and for gentlemen, especially the foreign members of the Association, was perhaps the most successful meeting held. Smoking was freely indulged in, and more was done in the way of promoting acquaintance and friendship between members of the Association than at any other time. Garden parties were held at Emmanuel College, by invitation of the High Sheriff, at Newnham and Girton Colleges, and at the Botanic Gardens, by the invitation of the Lord Lieutenant of Cambridgeshire and the Mayor of Cambridge. The lectures by Mr. J. W. Clark, Prof. Darwin, and Prof. Osborn were crowded, and Mr. Clark and Prof. Darwin repeated theirs to afford the many members who could not obtain tickets the opportunity of hearing them. On Monday honorary degrees were conferred in the Senate House upon representative leaders in science, and the speeches delivered on that occasion are printed elsewhere in this issue (p. 418).

Acting upon the suggestion of the council of the Association, several of the sections arranged discussions upon subjects of wide scientific importance, and devoted afternoon meetings to lectures of a semi-popular character. The discussions have in each case elicited the expression of inspiring and authoritative opinion, and when the subjects of the afternoon lectures have been of a character which appealed to members of the Association in general, and not only to members of a section, the lectures have been attended by large and appreciative audiences. This year's experience shows unmistakably that when sufficient care is taken in the selection of suitable lecturers and subjects, the afternoon addresses are most successful. For the benefit of members of the Association who are not actively engaged in scientific work, but are interested in the progress of natural knowledge, it is to be hoped that these lectures will be given a place in the programme of each section in future meetings.

In the physics sub-section of Section A, great interest was shown in the discussion opened by Prof. J. J. Thomson on radio-activity. Amongst other papers perhaps the most interesting was that of Prof. Rubens, on the optical properties of metals, in which he showed that the theory of Maxwell led to results for reflection from metallic surfaces, which agreed within the limits of experimental error with the actually observed results for infra red rays of wave length about thirty times that of visible light. This result was particularly interesting in the university of Maxwell, as for many years the non-agreement of the theoretical and observed results was regarded as limiting the applicability of Maxwell's theory to the range of steady currents and slow oscillations. The discussion on *n*-rays left those who heard it with the conviction that the phenomena said to be observed correspond to no objective physical reality. In the section devoted to economics the morning given to discussion of fiscal problems was of general interest. The opinion of scientific economists, as far as it was represented in the discussion, is distinctly in favour of free trade. The articles dealing with the separate sections will describe the results of the sectional meetings; the two mentioned have been introduced because of their general interest; the new theory of the constitution of matter being one which has appealed to all men of science as well as physicists, and the economic question being also one of interest wider than Section F. With regard to the new views of the constitution of matter, it seems unnecessary to take quite so serious a view as was expressed by the President of the Association. The new view is in no way contrary to older theories of the atomic and molecular theories of matter, but is an extension and explanation of these, and in the hands of Prof. J. J. Thomson, has made, at any rate to physicists, a simplification and rational view of these without introducing the question of physical reality.

One of the most interesting features of the meeting has been the museums and laboratories, which have been open for inspection during the Association week. Special mention should be made of the zoological exhibits, and the exhibit of teaching apparatus and experiments by Mr. Searle, in the Cavendish Laboratory. Among the demonstrations we may mention, as of special interest, that of Prof. R. W. Wood, of Baltimore, of the anomalous dispersion of sodium vapour; that of Messrs. Heycock and Neville, on methods of investigating metallic alloys, and of Prof. Schäfer, on methods of artificial respiration.

The report of the council which was presented to the general committee on August 17 referred to the organisation of the deputation which waited upon the Prime Minister on July 15, to urge the importance

of increased national provision being made for university education. The result of the action thus taken by the president at the request of the council has already been described in NATURE (July 21, p. 271). Several matters relating to the business of the officers of sections were mentioned in the report, and it was recommended that the following resolution sent to the council by the general committee for consideration, should be acted upon:—

That the sectional committees be continued in existence until the new sectional committees are appointed, and be authorised to bring to the notice of the council in the interval between the annual meetings of the Association any matter on which the action of the council may be desired in the interests of the several sections, and that a committee may be summoned at any time by the president of the section, or by the council.

Hitherto, the organisation of the work of the sections, and the arrangement of the programme, have been in the hands of the officers, but by this resolution the sectional committees are given a voice in the matter during the year between one meeting and the next, instead of ceasing to exist at the close of the meeting at which the members are appointed. The sectional committees, as at present constituted, are, however, so large as to be almost unmanageable as working committees, and probably the simplest practical way to secure continuity would be to select, say half a dozen members, from each committee to work with the officers during the year. The only other plan would be to limit the number of members to be appointed upon the committee of each section.

The members of sectional committees are not, in virtue of their membership, expected to take any essential part in the work of a section, though they may, and occasionally do, attend the meetings of the committees upon which they are appointed. In some cases vice-presidents understand their functions to be of the same negative significance, and neither attend the meeting for which they are appointed, nor send a timely notice of their inability to do so. To avoid this inconvenience the council has resolved that gentlemen nominated as vice-presidents of sections be informed that their attendance at the meeting for which they are nominated is expected.

Arrangements for the South African meeting in 1905 have received much attention during the year from a committee of council appointed for the purpose. The first half of the meeting will be held at Cape Town and the second half at Johannesburg, and official visits of the Association will be made to Natal and the Orange River Colony, in each of which colonies one or more discourses will be delivered by prominent members of the Association. The meeting will open at Cape Town on August 15, so that members starting for South Africa at the end of July will be able to spend at least three weeks in the colonies, and be back in England by the end of September. Prof. George Darwin will be the president of this meeting.

At the meeting of the general committee on August 19 the invitation to meet at York in 1906 was accepted unanimously.

Upon the proposal of Sir J. Dewar, seconded by Sir A. Rücker, Prof. J. Perry was elected to fill the office of general treasurer, in succession to Dr. G. Carey Foster, who has resigned that post.

A vote of thanks to Sir Norman Lockyer for the way in which he has discharged his presidential duties was proposed by Sir Henry Roscoe and seconded by Prof. Perry, and carried unanimously, as was also a similar vote of thanks to Dr. Carey Foster, moved by Sir A. Geikie and seconded by Major Macmahon.

SECTION A.

SUBSECTION, COSMICAL PHYSICS.

OPENING ADDRESS BY SIR JOHN ELIOT, K.C.I.E., M.A., F.R.S., CHAIRMAN OF THE SUBSECTION.

WHEN the suggestion was made to me that I should preside over this important Subsection my first thoughts prompted me to decline the honour. The position had been filled during the past two years by two distinguished physicists, both of whom had dealt chiefly with the problems and the position of meteorological science, and hence I thought that it should be offered to some representative of cosmical physics. I also doubted whether an official meteorologist whose time has been chiefly given up to duties of administration could have anything of interest to communicate to you. However, on fuller consideration it occurred to me that I might be able to place before you some features of Indian meteorology leading up to and assigning, as I hope, adequate reasons for the study of a portion of the field of tropical meteorology as a whole.

My address consists of three parts, viz.:

(1) A brief sketch of the broad features of the meteorology of India in their relations to the general meteorology of the Indo-oceanic region.

(2) Statement of abnormal features of the meteorology of that area for the unique period 1892–1902 illustrating the remarks in the preceding sketch.

(3) Suggestion of the co-ordination of the meteorological observations of the British Empire and the creation of a central office for the investigation of problems of general meteorology.

India is the most typical example of monsoon conditions, that is, of opposite air movements of six-monthly period which, in its case, depend on the annual temperature changes in the sea and land areas of the Indian Ocean and continent of Asia. The monsoon conditions in India are intensified by its unique position and topography. It projects southwards into the Indian seas over 15° of latitude, and is protected northwards by the vast barrier of the Himalaya Mountain range and Tibetan plateau. The axis of the Himalayan range is at least 2000 miles in length and has an average elevation of more than 20,000 feet. The extent of country more than 10,000 feet in elevation to the north of India is from 300 to 500 miles in width. These figures will give some idea of the magnitude of India's northern barrier.

During one period of the year there is an outflow in the lower atmosphere from land to sea. The direction of the lower air drift in India is determined in part by the lie of the mountains and river valleys, and is from north-east over the greater part of the Indian seas. January is the month most typical of this air movement and of the accompanying weather conditions.

During another portion of the year the lower horizontal air movement is from sea to land. This movement is much steadier and more powerful and influential in every respect than the former. July and August are the months most representative of the totality of the weather conditions of this period.

Conditions similar to those of January prevail in their entirety from about the middle of December to the end of February or middle of March—the period known in India as the cold weather or cool season. The lower horizontal air movement in India during the period has its origin in Upper India, where it is very feeble, and whence it increases seawards and is of moderate force in the Bay of Bengal (mean force 2 to 3, Beaufort scale) and the Arabian Sea (mean, 2 to 4). It is fed to a certain extent by drift down the river valleys, and passes in the North-West India frontier hill ranges. There is, on the other hand, no general drift down the Himalayan river valleys or across the main ranges from Central Asia. The normal air movement in the Western Himalayas (and perhaps the whole range) is an alternating up and down, or day-and-night movement, depending upon the diurnal heating and cooling of the plains of Northern India. Hence India (in its lower air movement) is at this time completely shut off from Central Asia.

The lower air movement is continued over the Indian seas southwards to a region of vertical movement over a narrow belt a little to the south of the equator. This belt

is also the goal of the lower air movement of the south-east trades circulation at this time. The equatorial belt of calms is hence the termination of the lower air movement of the south-east trades and north-east monsoon. It is chiefly an area of uptake, and of outflow northwards and southwards, to replace the lower air inflow from the distant south and north. The influx to the Indian land area occurs chiefly or entirely in the upper and (perhaps) middle atmosphere. There is also, as indicated by the wind directions in the lower Assam and Burma hills, an influx from the adjacent seas in the upper portion of the lower atmosphere.[1] The diurnal land and sea breezes alternate with great regularity on the west coast south of Gujarat during this period, but probably do not contribute to the general upper influx compensating in part or whole the lower outflow.

The circulation over the Indo-oceanic region hence consists at this time of two semi-independent circulations, with a common sink or goal for the lower air movement, which shifts with the season and with the relative strengths of the two movements. It is hence probable that they react on each other to some extent, and possible that general abnormal actions may affect the two similarly.

The normal weather during the period is similar to that which obtains in anticyclonic periods during the summer in Central Europe—viz., the prevalence of light winds, with clear or lightly clouded skies, low humidity, moderate temperature, and large diurnal range of temperature, with a bracing, exhilarating atmosphere.

It is interesting to note that the air movement in India itself is from opposite directions in Northern India and the peninsula, with a belt of unsteady movement over the area of the Vindhya and Satpura hill ranges. The variations of weather conditions from the normal are as a rule inverse in these two regions—viz., Extra-tropical and Tropical India.

The season of the opposite air movement is present in its most complete form in July and August, and lasts from the beginning or middle of June to the middle or end of September. It commences as a lower air movement in an anticyclonic region over the South Indian Ocean, and is thence continued northwards to Abyssinia, South Arabia, India, and Burma. Persia, Afghanistan, and Baluchistan (where dry hot north-west winds chiefly prevail) are outside the field of this movement. The direction of the movement is from south, with more or less easting to the south of the equator, and with more or less westing to the north of the equator, dependent in part upon the earth's rotation and in part upon local conditions and the influence of neighbouring land areas, and hence more effective in the Bay of Bengal than in the Arabian Sea. This lower air current advances over an extensive tropical oceanic region before it reaches Southern Asia, and hence arrives charged with vast stores of aqueous vapour, which it discharges chiefly over the peninsulas of Southern Asia and the mountain region of Abyssinia.

The regions of rainfall indicate the areas of upward movement terminating the lower advance of the current. The circulation is undoubtedly maintained in large part by the release or addition of energy due to the condensation of its enormous stores of aqueous vapour. The lower air movement is of very considerable elevation, estimated at 15,000 to 20,000 feet in India. Above it is the outward upper return movement, in part only compensatory, and in part probably slowly filling up the Central and Southern Asian low-pressure region. The movement exhibits some interesting features in India, due to the fact that of the three areas to which it is mainly determined India alone is subject to a double influx from two sea areas in opposite directions. The current from the Arabian Sea passes eastwards across the Malabar, Konkan, and North Bombay coasts, the peninsula and Central India. The Bengal current is deflected in the north of the Bay and Bengal, and advances in a westerly direction up the Gangetic plain. Between the areas or fields of the two currents (roughly proportional to their relative strength and importance—viz., about 2 to 1) is a debatable area of variable winds and low pressure. This trough of low pressure varies in position with the relative strengths of the two currents. The cyclonic storms of the period, which are of comparatively frequent occurrence, advance along the trough. It is hence a factor of considerable importance in determining the distribution of the rainfall of the period. The trough is purely a resultant of the peculiar conditions of the air movement, and is not the cause of that movement; in other words, it is determined by it, and does not determine it.

[1] In India the lower atmosphere may be defined as from 0 to 5000 feet, the middle atmosphere from 5000 to 15,000 or 20,000 feet, and the upper atmosphere above 20,000 feet.

The transformation of the double circulation of the north-east monsoon period into the single circulation of the south-west monsoon over the Indo-oceanic region next requires consideration. It is evident that the chief stages in this change are (1) the discontinuance of the vertical movement over the equatorial belt; (2) the extension of the trade winds of the south-east trades across the equatorial belt, with an accompanying increase of pressure and of horizontal air movement; (3) the continuance of that northerly movement over the Indian seas into the peninsulas of Southern Asia.

The marine data of the Indian seas collected during the past fifteen years establish fully that this transformation is primarily due to actions in the Indian Ocean, producing a movement resembling in many respects that of a bore or storm wave. The actual transition may hence be described as catastrophic, due to impulsive action.

It is preceded in India by a period of preparation (as it may be termed), when pressure and other conditions are slowly established in Southern Asia, which directly contribute to the advance of the monsoon winds over the Indian seas, but which in no way assist the preliminary burst across the equator, the first stage towards the establishment of the south-west monsoon circulation.

This preliminary period is the hot-weather season, lasting from about the middle of March to the middle of June (on the average in Northern India). During this period temperature increases rapidly until the last week in May or first week of June, when maximum day temperatures ranging between 120° and 125° are usually recorded in the driest and hottest interior districts of Northern and Central India. Pressure decreases *pari passu* in the heated land areas of Southern Asia, which become areas of low pressure and indraught relative to the neighbouring seas. The indraught only extends to a comparatively short distance landwards and seawards from the coasts, more especially in the larger sea area, the Arabian Sea, over the centre of which light variable or northerly winds obtain even immediately before the advance of the monsoon currents. In the interior of Northern and in Central India exceedingly dry and hot westerly winds prevail with great steadiness.

The weather in India during this period depends almost entirely upon local thermal actions and contrasts of temperature and humidity conditions. Skies are generally free from cloud, but the air is more or less charged with dust and is excessively dry (humidities of 1 to 5 being of occasional occurrence in North-Western India).

The characteristic features of the dry season are hence most strikingly exhibited immediately before the advent of the wet monsoon. There is no gradual change over the greater part of India from one to the other such as would occur if the furnace, or Central Asia hot area, theory were correct. Over small isolated portions of India, including Tenasserim, Arakan, Lower Burma, Assam, Bengal, and Malabar, thunderstorms giving more or less heavy downpours occur in increasing frequency during the period. The rainfall is considerable to large in amount in these areas, and is of much agricultural value in some districts—*e.g.*, in Assam for the tea crop. In those areas the transition to the rainy season is much less abrupt and spasmodic, the chief differences being that the rainfall in the wet season is more general and frequent, larger in amount, *and rarely accompanies thunderstorms*.

The transformation from the hot weather to the rains is usually effected between June 1 and 15. It commences in the equatorial belt with a considerable increase of pressure and air movement accompanying a strong rush of southerly winds, the continuation of south-east trade winds, across the equator. If the burst be sufficiently strong the rush is continued northwards over the Indian seas as a wave of disturbance, squally weather, heavy rain, and much violent electric discharge or action, invading areas characterised previously by light and variable winds and fine weather. The disturbance usually increases with its

northward advance, and frequently, when it reaches lat. 12° to 16° N., it concentrates into a cyclonic storm. Such a storm almost invariably marks the commencement of the monsoon in the Bay of Bengal, and in about two out of five years in the Arabian Sea. The advancing humid currents in the rear of these initial cyclonic storms or waves of disturbance march over the sea areas in a few days, and thence cross the coasts towards which they are determined by the low-pressure regions in the land areas of Southern Asia, where they produce an almost complete reversal or transformation of the weather conditions, the result of which is that moderately high temperature and small diurnal range of temperature, great humidity frequently approaching saturation, much cloud, and frequent rain obtain for the next three months over the greater part of India, until, in fact, the middle or end of September.

The reverse change—viz., the withdrawal of the humid south-west currents—then commences, and is a slow process, requiring usually from two to three months for its completion.

This is due to a gradual decrease of strength, and hence to a fairly continuous contraction of the field of the current, and also of its elevation or thickness. The current first withdraws from North-Western India, being replaced by light, variable, or north-westerly land winds. These land winds increase in extension and volume with the continued contraction of the south-west monsoon current. The more important phases of the contraction and withdrawal of that circulation from India are of especial interest. The first phase, the retreat of the current from North-Western India, accompanies a rise of pressure over the Persian area and North-Western India, with a shift of the trough of low pressure from W.N.W. to N. or N.E. and corresponding change of direction of the average tracks of the storms of the period. This is followed after a short period of rain in North-Eastern India and Burma by a rise of pressure in Assam, Upper Burma, and Bengal, and the withdrawal of the monsoon current from those areas. The current then recurves over the centre of the Bay, in the same manner as during the monsoon proper over the north of the Bay and Bengal, and is directed or determined to the west or Madras coast of the Bay, which hence receives frequent rain during a short period of about two months—the rainy season of the eastern and southern parts of the peninsula south of Orissa and Ganjam.

These rains were formerly described as accompanying the setting in of the north-east monsoon on the Madras coast. That, however, is a misnomer, as the true north-east monsoon winds are dry land winds, and the rain-giving winds of this period in Madras are those of the south-west monsoon in its retreat or contraction down the Bay. The period during which this rainfall occurs is hence now usually termed the retreating south-west monsoon.

The year in India may hence be divided into two monsoons of nearly equal length, viz. :

(a) The north-east or dry monsoon.

(b) The south-west or wet monsoon.

The first terms are based on the general direction of the air movement in the Indian seas during the periods, and the second on the most prominent feature of the weather in India itself. Of an average annual total rainfall of 41 inches (according to the most trustworthy calculation), at least 85 per cent. falls during the wet season, and only 15 per cent. during the dry season.

The dry monsoon in India is subdivided into—

(1) The cold-weather period.

(2) The hot-weather period or transitional period of preparation for the south-west monsoon.

The wet monsoon is divided into—

(1) The south-west monsoon proper, or the period of general rains.

(2) The period of the retreating south-west monsoon and gradual slow establishment of the dry monsoon.

Each of these periods practically covers three months.

One of the most noteworthy features of the meteorology of India not referred to in the previous statement is that the storms of each period—viz., the cold-weather period, the hot-weather period, and the wet monsoon—are characteristic and special to the period. They are all in the broadest sense of the word cyclonic in character; but they originate under different conditions and exhibit very different features in each of those periods.

The disturbances of the cold weather are large shallow depressions which originate in the upper humid return current of the north-east monsoon circulation, chiefly in the Persian plateau region, and which drift eastward with a slight southing across Extra-tropical India. Storms do not occur south of the Deccan or peninsula-dividing ranges during this period. These storms are chiefly remarkable for the frequent development of stationary secondary depressions in the Punjab, usually of much greater intensity than the primaries; a feature of which, I believe, there is no parallel elsewhere. They are of great importance, as they give the main snow supply to the Western Himalayas and the light but general occasional rain required for the wheat and other cold-weather crops of Northern India.

The storms of the hot weather are local disturbances of very limited extent, usually in large areas of slight depression, and are occasionally of remarkable intensity and great violence. In the areas to which the local sea winds of the period extend (more especially Bengal and Assam) they occur chiefly as local thunderstorms with violent winds and brief heavy downpours of rain, but sometimes as tornadoes rivalling those of certain districts of the United States in intensity and destructiveness. In the dry interior they occur as dust-storms, usually without rain, and are most violent in the driest districts, including Sind, the Punjab, and Rajputana. Occasionally, when the convective movement is especially vigorous, they develop into hailstorms of great intensity. The rainfall accompanying these hot-weather storms is of little general agricultural value except in the tea districts of Assam and Bengal.

Finally, the wet monsoon is characterised by the frequent occurrence of cyclonic storms of every degree of intensity and of very varying extent. The great majority of them originate in sea areas of nearly uniform temperature as disturbances in a massive current highly charged with aqueous vapour and subject to large variations of intensity and extension. The more prominent features of these storms, more especially of the most violent, including the hurricane winds, excessive rainfall, and the phenomena of the central calm and the accompanying storm wave, are too well known to require description. The chief importance of these storms, of which an average of about ten (of different degrees of intensity) occur every year during this period, arises from the manner in which they modify the distribution of the rainfall, discharging it abundantly over the districts traversed by the storms at the expense of the districts outside of their field.

The most important and variable feature of the weather in India from the practical standpoint is rainfall. Its value depends upon its amount and occurrence in relation to the needs of the staple crops. The measurement of rainfall is carried out, on a uniform system, at upwards of 2500 rain-gauge stations. The average distribution of rainfall, month by month and for each season, has been determined from the data of about 2000 stations. It should, however, be recognised that the probability that the rainfall will conform exactly to this distribution in any year is nil. Average rainfall charts represent a distribution about which the actual varies from district to district more or less considerably, the local variation for prolonged periods being practically compensatory. Such mean or normal data and charts are undoubtedly of value, more especially for the determination of rainfall anomalies and their relations to pressure, temperature, and other anomalies. There is apparently a tendency to assign a greater value to these charts of mean rainfall distribution than they deserve. Charts showing the amount and time distribution of the rainfall best suited for the requirements of the staple crops would—for India at least—be more interesting and valuable. This is a work that I regret has, for various reasons, not yet been carried out by the Indian Meteorological Department.

In most regions in India a moderate variation (positive or negative) in the amount of the rainfall is of comparatively small importance, more especially if the precipitation occurs in amount and at intervals suited to the requirements of the crops. During the thirty-year period 1874–1903 there were six years in which the distribution of rainfall affected

to a serious extent the crop returns over large areas, and the rainfall was not compensatory. In four of these years the drought was so severe and widely spread as to occasion famine, with its attendant calamities, over large areas. Severe droughts and famines occur at very irregular intervals. A noteworthy feature is that they frequently follow in pairs separated by intervals of two to four years.

The previous statement of the meteorology of India has indicated the chief conditions which affect the crop returns seriously or disastrously over large areas in India. They may be summed up briefly as follows:—

(*a*) The dry monsoon. Absence or unusual feebleness of cold-weather storms.

(*b*) The wet monsoon. General feebleness of the monsoon current, due either to corresponding feebleness of the south-east trades, or to unusual diversion to East Africa; or local feebleness in a part of India, due to local conditions, or to abnormal diversion to other rainfall areas in South Asia. These conditions give rise in the areas affected to one or more of the following features:—

(1) Prolonged delay in the commencement of the rains.

(2) Scanty rainfall during the season, with prolonged periods of fine, clear, hot weather.

(3) Early termination of the rains.

These features are as a rule more marked in the drier districts of the interior than in the coast districts. The effect on crop production is greatest and most disastrous in the following areas:—

(1) Central Burma.

(2) The Deccan, including the Bombay and Madras Deccan districts, and Hyderabad.

(3) North-Western and Central India, more especially the South Punjab, East Rajputana, and the United Provinces.

The following important inferences are based upon the preceding presentation of facts and the experience of the past thirty years:—

(1) The lower air movement of the south-west monsoon is the northward extension of the lower movement of the south-east trades. The latter is a permanent feature of the Indo-oceanic region, and the former a periodic invasion of the Southern Asian seas and peninsulas initiated over equatorial regions and propagated northwards to the southern mountain barrier of the Central Asian plateau.

(2) The primary factors determining this impulse across the equator (the first stage of the establishment of the south-west monsoon) are to be sought in the permanent field of the south-east trades, and are not due to actions in the heated areas of Southern or Central Asia.

(3) The pressure conditions in the heated areas of Southern Asia and North-East Africa determine the direction, volume, and intensity of the advance over the Indian seas to what may be termed three competing areas for rainfall (viz., Abyssinia, India, and Burma). These conditions are hence important factors in the third stage of the advance of the south-west monsoon current.

(4) The movement when fully established by these actions over the Southern Asian seas and peninsulas is continued—first, by the momentum of the lower circulation; secondly, by the release of energy accompanying aqueous vapour condensation; and thirdly, by thermal actions in Southern Asia, due to direct solar activity. The termination of the lower horizontal current by vertical movement occurs irregularly over the areas of frequent heavy rain in Southern Asia and Abyssinia, and not over a heated area in Central Asia.

(5) The total volume of aqueous vapour brought up by this circulation not only varies in amount from month to month during the season, but also from year to year. The largest variations (seasonal and annual) depend chiefly, if not entirely, upon actions in the source of supply—viz., the Indian Ocean. If those actions determine an increased or diminished supply across the equator into the Indian seas, there is a corresponding variation in the total precipitation of the three competing areas. Amongst such causes and actions may be prolonged and untimely diversion of the south-east trades into East Africa, as in 1896, or general weakness of the air movement over the Indian Ocean, probably accompanying a displacement and decreased intensity of the southern anticyclone, as in 1899.

(6) The relative distribution of the total rainfall in the three areas of discharge of the aqueous vapour of the monsoon currents probably depends upon the relative intensities of the pressure conditions established during the hot weather, which are continued for a part or the whole of the monsoon by actions depending on the rainfall resulting from the initial pressure conditions—an example of the persistence of meteorological conditions and actions which is a prominent feature of Indian meteorology. The total rainfall of each of the three areas may differ considerably from the normal, but there may be partial or complete compensation on the whole. Thus it is the general (but not the invariable) rule that the rainfall variations in Burma and Assam are usually inverse to those of North-Western India and also of India as a whole.

(7) The distribution of the rainfall in any one of the three competing areas (but more especially in India as the largest) may vary widely from the normal—considerable deficiency in some areas accompanying considerable excess in others. This in India is undoubtedly due to local conditions—*e.g.*, local excess or deficiency of pressure at the commencement of the period and established during the previous hot weather. These pressure variations usually accompany abnormally prolonged and heavy snowfall or very scanty snowfall in the Western Himalayas.

(8) Local or general drought in India during the south-west monsoon may hence be due to—

(*a*) General weakness of the south-east trades circulation.

(*b*) Diversion of an unusually large proportion of the south-east trades to South-East or East Africa during the monsoon period.

(*c*) Larger diversion than usual of the monsoon currents to Burma or Abyssinia.

(*d*) Very unequal distribution in India itself, due to local conditions established during the antecedent hot weather.

These factors are given in the probable order of their importance.

(9) Scanty rainfall or drought during the dry season or north-east monsoon in Northern India results from absence or unusual feebleness of the cold weather storms which are the sources of rainfall at that time.

(10) The most prolonged and severe droughts in North-Western and Central India are due to the partial or complete failure of the rainfall of at least two seasons in succession.

(11) As the two circulations in the Indian oceanic region have a common goal in the dry season (more especially from December to March), it is probable that variations in the strength of one circulation (more especially the larger) will modify the field and strength of the other circulation. It appears that this relation would be shown most strongly between the southern circulation and the upper movement of the northern circulation. And, as cold-weather storms are disturbances in that upper movement, it is possible—if not probable—that the larger variations in the number and intensity of the cold-weather storms and the amount of the cold-weather precipitation may be related to conditions in the south-east trades regions.

(12) There appears to be little or no relation between the position and intensity of the Central Asian anticyclone and the number of the cold-weather storms and rainfall of Northern India in any season.

The meteorology of the period 1892–1902 is of especial interest for its confirmation of the above inferences, more especially the phenomena of the variations of rainfall in India and the causes or actions to which they are due. The year 1891 was noteworthy for a severe local famine in Rajputana and the adjacent districts to the north and east consequent on prolonged and excessive snowfall in the Western Himalayas during the winter of 1890–91. The following gives a brief summary of the more prominent features of the meteorology of this unique period:—

(1) The eleven-year period 1892–1902 corresponds in length to the sun-spot period, and it may be divided into two periods of unequal length—a short period of excessive rain and a long period of deficient precipitation. The maximum of the first period was in 1893. The second period had three strongly marked minima in 1896, 1899, and 1901, that of 1899 being the absolute minimum. The following table gives, for convenience of reference, data of the mean annual and seasonal variations of rainfall of the Indian land area for each year of the period:—

Variation of Mean Actual Rainfall of Period from Normal.

	Cold Weather: January and February	Hot Weather: March to May	South-west Monsoon. Complete Period: June to December	Whole year
1891	+0·34	+0·37	− 4·25	− 3·54
1892	0·39	−0·21	+ 5·69	+ 5·09
1893	+1·63	+2·72	+ 4·72	+ 9·07
1894	+0·48	−0·76	+ 6·75	+ 6·47
1895	−0·01	−0·23	− 1·95	− 2·19
1896	0·42	−0·82	− 3·59	− 4·83
1897	−0·01	−0·12	− 0·02	− 0·15
1898	−0·50	−1·00	+ 0·93	+ 0·43
1899	0·38	+0·58	−11·34	−11·14
1900	−0·02	−0·25	− 0·26	0·57
1901	+1·47	−0·48	− 5·12	− 4·13
1902	−0·57	+0·16	− 1·64	− 2·05
Normal roughly..	1 inch	5 inches	35 inches	41 inches

(2) The following gives the chief features of the rainfall of the first period, 1892–4:—

(*a*) The excess was almost as marked in the dry as in the wet season. This is strongly shown in the year 1893 of maximum excess.

(*b*) The excess was on the whole more strongly exhibited in the field of the Bombay than of the Bengal current.

(*c*) The rainfall of the dry season was as markedly in excess in Persia, Baluchistan, Afghanistan, and the Himalayan area as in Northern India.

(*d*) The maximum height of the Nile floods (in September) was above the average. They were abnormally high in 1892 and 1894.

(*e*) The rains were favourable over Australia and South Africa during this period, according to the reports received in India.

(*f*) Hence, as a general inference, the rainfall was in general excess in each year of the period over the Indo-oceanic region, and not only in the south-west but also in the north-east monsoon in Southern Asia.

(3) The chief features of the rainfall of the second period, 1895–1902, in the Indo-oceanic region were as follows:—

(*a*) The rainfall was as deficient relatively to the normal in the cold weather as in the rains or wet season.

(*b*) The cold-weather or winter precipitation was almost continuously in marked defect in Asiatic Turkey, Persia, Afghanistan, Baluchistan, the Himalayan area, and South Tibet. The opposite variation obtained in Central Asia, as is shown by available data for Tashkend, Samarcand, Irkutsk, and other stations.

(*c*) The storms of the cold weather were fewer in number and feebler in character in each year of the period than on the average of the preceding sixteen years 1876–91.

(*d*) The south-west monsoon rainfall was most largely in defect in the interior districts served by the Bombay current.

(*e*) There was a marked tendency in each year for late commencement and early withdrawal of the monsoon currents, and for deficient rainfall throughout the whole season over the greater part of India. These features were very pronounced in the years 1896, 1899, and 1901.

(*f*) The most remarkable feature of the period was that the region to the south of the equator, including South and East Africa, Mauritius, and Australia, was similarly affected.

In India the years 1896 and 1899 were years of severe drought, followed by famine over very large areas. The area in which the crops failed more or less completely was about 250,000 square miles in extent in 1896 and 500,000 square miles in 1899. In the 1899–1900 famine upwards of 6,500,000 people were on famine relief for several months. The loss of cattle due to failure of water and fodder was very great, numbering many millions. In some districts from 90 to 95 per cent. of the cattle died off from slow starvation and want of water. In New South Wales and Queensland almost continuous drought prevailed from 1896 to 1902. It is estimated that more than fifty millions of sheep, value 12,500,000*l*., were lost in New South Wales during these seven years of drought.

Mr. Hutchins, Conservator of Forests, Cape Town, states that drought prevailed more or less persistently over the Karoo region in South Africa from 1896 to 1903, and that cattle and sheep perished by millions. He also states that the drought extended to British Central Africa from 1898 to 1903.

The previous statements evidence the continuity, extension, and intensity of the drought.

The Nile floods followed very closely the variations of the rainfall in Western India. The floods of the years 1899 and 1901 were both amongst the lowest on record. This shows that the rainfall in the Abyssinian region was more or less generally in defect during the period and most largely in the years 1899 and 1901, when the rainfall of the Bombay current was very deficient.

Hence, as a general inference, the period 1895–1902 was characterised by more or less persistent deficiency of rainfall over practically the whole Indo-oceanic area (including Abyssinia). The economic results in the dry interior districts of India, South Africa, and Australia were the same—large loss of cattle and great loss of capital. The drought in Southern Asia was as marked in the north-east as in the south-west monsoon, and hence the variation was not seasonal but general.

The variations of temperature, humidity, and cloud in India during the whole period were large and in direct accordance with the rainfall. In other words, during the period 1892–94 the air was damper with lower temperature than usual, and cloud above the normal. On the other hand, from 1895 to 1902 temperature was steadily in excess, cloud less than usual, and humidity below the normal.

The most remarkable variation was that of the solar radiation as indicated by observations of the solar radiation thermometer (black bulb *in vacuo*).

The most interesting feature of the meteorology of the period 1892–1902 is that the variations of the solar insolation are the inverse of those which might have been expected from the cloud and humidity data. In other words, solar radiation was in excess in the period of increased humidity and cloud, and in defect during the greater part of the period of drought, decreased humidity, and cloud. The series of eight curves exhibited, out of a larger number prepared from the data of a number of stations in India at which these observations are carefully recorded, show the most important facts, and indicate that there was a continuous decrease of insolation on the average of all stations from 1891 to 1902. The curves for Aden, Calcutta, and Leh, it will be seen, agree in their most important features. The observations are quite concordant and probably represent a most important feature of the period. They indicate either a continuous and considerable decrease of emission of solar energy during the period, or unusually large absorption in the upper atmosphere. In order to decide this question comparison is necessary with similar data for other large areas as, for example, Europe and North America. It is, however, clear that in India the insolation data of this unique period are of exceptional interest and value.

The preceding statements have shown that variations of rainfall for prolonged periods similar in character have occurred, and may hence occur again, over the very large area including the Southern Asian peninsulas, East and South Africa, Australia, and, perhaps, the Indian Ocean. The abnormal actions or conditions giving rise to these large and prolonged variations must hence be persistent for long periods, and be effective over the whole of that extensive area, and hence cannot be inferred with certainty from the examination of the data of one small portion of the area affected—*e.g.*, India. The variations undoubtedly accompany variations in the complete atmospheric circulation over the Indo-oceanic area, and the effective forces or actions must be such as to influence the whole movement in a similar manner in the two monsoons or seasons of inverse conditions in Southern Asia. This inference furnishes a very strong reason for the conclusion that the meteorology of the whole area similarly affected from 1892 to 1902 should be studied as a whole, and not in fragmentary

detail by various weather bureaus, and as at present without any co-ordination of the results of these bureaus.

The discussion has also indicated that the south-west monsoon current is a periodic or intermittent extension of the permanent circulation of the south-east trades to the peninsulas of Southern Asia, and also that variations in the strength, volume, and direction of movement of the latter affect the extension, volume, aqueous vapour contents, and precipitation of the south-west monsoon currents in Burma, India, and Abyssinia. This fact further emphasises the necessity for the co-ordination and systematisation of the work of observation in the Indo-oceanic meteorological province and the continuous and systematic examination and discussion of observations for the whole of that area.

It is, of course, possible that it may be necessary to extend this work to a larger area than the Indo-oceanic region. For Sir Norman Lockyer and Dr. Lockyer have shown that similar pressure variations to those of Bombay occur over a large portion of the Eastern Hemisphere, and variations of opposite sign (similar to those of Cordova) over a considerable part of the Western Hemisphere.

The Indian Meteorological Department, with the sanction of the Government of India, is now arranging to collect and tabulate data for the whole area between the Central Asian winter anticyclone and the permanent South Indian Ocean anticyclone, and to utilise the information for the investigation of the causes of the large and general variations of rainfall in Burma and India from year to year. This extension of its labour is recognised as necessary for the improvement of the seasonal forecasts, an important feature of the work of the Department the value and importance of which are fully recognised by the Government of India.

Possibly the practice of the Indian Meteorological Department in the preparation and issue of long-period or seasonal forecasts is considered to be not only unscientific, but not justified by comparison with facts. Prof. Cleveland Abbe, in his paper on "The Physical Basis of Long-range Weather Forecasts," expresses his opinion that "we are warranted in saying that during the thirteen years (1888–1900) the only real failure has been that of the prediction of the monsoon season of 1899, the year of phenomenally great drought in that country." This opinion is probably more favourable than I should myself give, but it is the opinion of an independent meteorologist eminently qualified to give a judgment in the matter.

My own opinion with respect to weather forecasts is that there appears to be too strong a desire for absolute accuracy, possibly due to public and newspaper criticism. Certainty is not possible in weather forecasts based on imperfect information, and in which the introduction of a single unknown factor in regions beyond observation—*e.g.*, the upper or middle atmosphere—may completely alter the course of events. Percentages of success are an inadequate measure of the utility of forecasts. To be of real value as estimates of utility they should be calculated rather on the information required, and which might be reasonably expected, than on that actually given.

It appears to me that the striving after perfection in short-period forecasts to the exclusion of other claims is impeding the extension and progress of meteorology in other useful directions. It is absolutely essential that officials preparing or utilising forecasts should recognise that every forecast is based on imperfect information and experience, and hence that all important forecasts should be expressed as probabilities, and, whenever desirable, an estimate of the value of each probability be given.

The Government of India desires to have these seasonal forecasts, and has ordered its Meteorological Department to furnish them. The Government encourages the work, provides the additional means required by the Department for its proper performance, and issues the forecasts only to those who will use them as probabilities for practical guidance.

The importance of the work of seasonal forecasting in India may be judged from the following remarks:—

India is almost exclusively an agricultural country, with a population of nearly 300 millions. The material prosperity of practically the whole people is determined by the amount and distribution of the periodic rains. The variations in the amount and period of the rains are occasionally so great as to produce the most disastrous results in the staple crops over large areas. In 1899, for example, the crops failed more or less completely over an area several times the extent of England.

There is probably no country where the meteorological problems, of which these rainfall variations form one feature, are of greater interest or more practical importance. The daily weather and rainfall reports are studied during the greater part of the year with the closest attention by the officials, from the Viceroy downwards.

The Government is hence keenly interested in meteorological observation and investigation, and is most anxious to improve its meteorological service and utilise it for practical purposes, of which seasonal forecasting is one of the most important. To give two examples. A reassuring forecast at a critical period, followed by its realisation, might be of the greatest value to the agricultural population of a large province, as well as to the local and Imperial Governments. Again, a statement or forecast the probability of which was, say, at least 10 to 1 that the rains would fail more or less completely during a season over a large area might enable the Government to carry out early prudential measures for relief in the most economical and effective manner with the means at its disposal. The preparation and issue of seasonal forecasts will hence, I am confident, be in the future, as in the past, one of the most important duties of the Indian Meteorological Department.

There are several points in connection with weather forecasting in India which it is desirable should be borne in mind. The first is that weather in India is distinguished rather by the massiveness, intensity, and persistence of abnormal features than by the frequency and rapid succession of important weather changes. It is chiefly on this account that daily weather forecasts, even if they could be communicated with the necessary rapidity, are of no value to the Indian agricultural population. Also, the empirical knowledge of the significance of the important variations as factors determining or indicating future weather accumulates much more slowly than in Europe, and it is hence doubly important that in India the empirical knowledge derived from very limited experience should be, so far as possible, regulated and controlled by theory and scientific knowledge. It should also be remembered that there are large differences between the meteorology of tropical and temperate regions, and also between the relation of crops to weather in India and England. The instincts, habits, beliefs, education of the body of the people in England and India also differ very widely. Hence the possibilities of the practical applications of meteorological science in India cannot be judged from the European standard, and may from that standpoint be unique.

The possibilities of usefulness of the work of seasonal or long-period forecasting in India are almost unlimited. To be acceptable and useful to the agricultural population of areas liable to drought they should be fairly accurate with respect to the dates of commencement and termination of the periodic rains, their general character, and the probable occurrence of prolonged breaks likely to be injurious to the chief food crops. If the forecasts were found to be fairly trustworthy in these respects, it is quite certain that the agricultural population would value them and use them. Indications of a growing belief in the utility and value of this feature of the work of the Department by the people in different parts of India are not wanting.

The Government of India has sanctioned large changes in its Meteorological Department in order to enable it to carry out the extensions of work that recent experience has shown to be desirable. The Department is kept in touch with scientific opinion and judgment at home through the Observatories Committee of the Royal Society. The relations to other scientific departments in India are maintained by a special committee termed the Board of Scientific Advice. The scientific staff has been largely increased. The solar physics observatory at Kodaikanal and the magnetic observatory at Bombay have been placed under the Meteorological Department with a view to the complete co-ordination of the departments of scientific investigation for which they are maintained. Observational data for the whole Indo-oceanic area are now being collected and tabulated with a view to the early publication of daily and monthly weather reports and charts of that area.

The objects of this last extension have already been indicated. It will afford the Indian meteorologists the data necessary for the investigation of the extension and intensity of the more important variations in the meteorology of the whole region, to correlate the abnormal features in the atmospheric circulation over the area, and more especially to ascertain the causes of the occasional failure of the monsoon rains in India. Finally, it will, it is hoped, enable the Department to collect the information and acquire the additional experience necessary in order to render the seasonal forecasts more trustworthy and satisfactory than they have been during the past six or seven years.

The area to be dealt with (viz., the Indo-oceanic area) is partially covered by a number of independent meteorological systems, including those of Egypt, East, Central and South Africa, Ceylon, Mauritius, the Straits Settlements, and Australia. Large areas, as, for example, Arabia, Persia, Afghanistan, Tibet, and the greater number of the islands of the Indian Ocean, are now almost completely unrepresented.

The departments controlling these systems work independently of each other, chiefly for local objects, and are in no way officially correlated or affiliated. Their methods of observation and of discussion and publication of meteorological data differ largely. It is hence difficult, if not almost impossible, to make satisfactory comparisons of the data, and trace out for the work of current meteorology the extension or field of similar variations, their relations to each other, and their probable influence on the future weather.

The work which should be carried out in order that the investigation of the meteorology of the Indo-oceanic area might be effective and as complete as possible includes the following:—

(1) The extension of the field of observation by the establishment of observatories in unrepresented areas, and the systematic collection of marine meteorological data for the oceanic area.

(2) The collection and tabulation of the data necessary to give an adequate view of the larger abnormal features of the meteorology of the whole area.

(3) The direction by some authoritative body of the registration, collection, and tabulation of observations by similar methods in order to furnish strictly comparable data for discussion.

(4) The preparation of summaries of data required as preliminary to the work of discussion, and for the information of the officers controlling the work of observation in the contributory areas. The earliest publication of the data should be regarded as essential for the use of officers issuing seasonal forecasts.

(5) The scientific discussion of all the larger abnormal features in any considerable part of the area and their correlation to corresponding or compensatory variations in the remainder of the area by a central office furnished with an adequate staff.

(6) Possibly, sufficient authority on the part of the central office to initiate special observations required for the elucidation of special features for which there are no arrangements in the general work of the various systems.

The Indian Meteorological Department is making preparations to carry out a portion of this work; and will undoubtedly do the best it can single-handed with its limited means. It cannot do the work fully and as it ought to be done. It can do nothing which requires authoritative control over the remaining meteorological systems in the Indo-oceanic field. It is collecting information from those who are willing to supply it, and will utilise it for its special purposes.

It is evident the work can only be carried out fully by the co-operation of the various systems subject to limited control by a central office with acknowledged imperial or general authority behind it. The most important part of the work from the standpoint of the science of meteorology is the comparison and discussion of the whole body of observations. The constitution, position, and authority of the central office is hence of the greatest importance. It is quite certain that none of the meteorological systems directly concerned can provide such a central office. If the work is to be carried out fully and systematically it can only be arranged for in England, and by the English Government assuming the general direction and control. At the present time a section of the English Meteorological Office is devoted to the study of oceanic meteorology for the information of mariners. Another section should be created for the study of imperial meteorology for the benefit of its dependencies and colonies. I have reason to believe that the Government of India would contribute its share towards the cost of this extension of work.

In the preceding remarks are given the chief reasons for an important extension of work now in progress in the Indian Meteorological Department, an extension which can only be carried out imperfectly by that Department, but which could be performed with most valuable scientific results by the co-ordination of the labours of the weather bureaus concerned, with a central institution or investigating office in England under Government control.

Perhaps I may be permitted, from my Indian experience, to add some general remarks bearing on the methods and progress of meteorological inquiry.

In India the collection and publication of accurate current data relating to rainfall and temperature is required for the information of Government in its various Departments. The collection and examination of pressure and wind data by a central office with a view to the issue of storm and flood warnings is equally necessary. This work may, perhaps, be described as pertaining to descriptive or economic meteorology.

Economic meteorology, so long as it deals only with actual facts of observation, is not a science. Forecasts belong to the same department or branch of meteorology. They may be based on scientific theory and be obtained by scientific methods or the utilisation of empirical knowledge. The latter method is probably sufficient for by far the greater part of short-period forecast work, but the final development of that work and the preparation of long-period forecasts require the application of exact scientific methods and knowledge. And it is, perhaps, not too much to say that the extension of the range or period of forecasts is a measure of the progress of meteorology as a science. India, by the simplicity and massiveness of its meteorological changes (and perhaps Australia and Africa), appears to be best suited for the earliest experiments in this work.

India is, however, poor, not only in material wealth and capital as compared with England, but also in the appliances and means of scientific investigation, and hence looks to England for assistance and guidance in scientific matters. Unfortunately, England lags behind, not only the United States and Germany, but even behind India, in the important field of scientific meteorological inquiry. It will suffice to give a single illustration of the anomalous and inferior position which England takes in such matters.

All meteorologists and scientific men generally are agreed that the exploration of the middle and upper atmosphere by any available means—*e.g.*, kites, balloons, &c.—is of the utmost importance at the present stage of meteorological inquiry. The United States, France, and Germany have taken up the work vigorously. The English Meteorological Office is unable, for want of funds, to share or take any part in the work. The force of scientific and public opinion is apparently powerless to move the English Government to grant an extra five hundred pounds annually for this work. The English Government, on the other hand, some time ago suggested that the Indian Meteorological Department should assist. The Government of India, recognising the importance of the work, has provided the funds and sanctioned the arrangements necessary in order that its Meteorological Department may march with the most progressive nations in this investigation.

India has no body of voluntary observers or independent scientific workers and investigators. Whatever is required to be done to extend practical and theoretical meteorology can only be effected by the Government Department to which that work is assigned, with the sanction and at the cost of the Government—which naturally considers chiefly its practical wants in relation to its limited resources. It is, from one point of view, a painful if not quite an unexpected experience to me, on my retirement, to find that the Government of India is, in its attitude towards meteorological inquiry, more advanced, more liberal and far-sighted than the English Government, and that England has not yet taken up seriously the work of scientific meteorological

investigation. There are undoubtedly too many observations and too little serious discussion of observations. The time has arrived when investigation should go hand in hand with accurate observation, and should direct and suggest the work of observation, and also that the sciences directly related to meteorology should be considered concurrently with it. There are undoubtedly definite relations between certain classes of solar phenomena and phenomena of terrestrial magnetism. The probability of definite relations between solar and terrestrial meteorological phenomena is also generally admitted.

Data for the determination of these relations are being rapidly accumulated, and numerous problems connected therewith are waiting and ripe for investigation. They are too large and complex to be undertaken by present English methods, and can only be attacked by a body of trained investigators under arrangements securing the continuity of method and thought requisite for the prolonged systematic inquiry gradually leading up to their complete solution.

It would hence be desirable to enlarge the scope of the central institution I have suggested, so as to include in its field of labour the investigation of the relation between solar and terrestrial meteorology and magnetism, so far as they can be solved by the comparison of the observations of the British Empire.

The central institution would thus have large and definite fields of work and most interesting problems for investigation. It would hence contribute towards the formation of a body of scientific meteorological investigators adequate to the importance and wants of the empire, and be of the highest educational as well as scientific value.

My predecessor in this position, Dr. Shaw, the head of the English Meteorological Office, made some remarks in his Address last year which deserve repetition in connection with this idea. He said: "The British Empire stands to gain more by scientific knowledge, and to lose more by unscientific knowledge, of the matter than any other country. It should from its position be the most important agency for promoting the advance of meteorological science, in the first place because it possesses such admirable varying fields of observation, and in the second place because with due encouragement British intellect may achieve as fruitful results in this as in other fields of investigation."

The establishment of the central institution as suggested above would provide a remedy for the defects pointed out by Dr. Shaw. The reorganisation of the English Meteorological Office is, I believe, under consideration. Is it too much to hope that a strong expression of opinion on the part of the British Association, and the influence of the learned University at which its present meeting is held, would induce the English Government to spend an additional 5000*l.* or 10,000*l.* annually for the promotion of meteorological investigation and the establishment of a central imperial institution in London in connection with its Meteorological Office?

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY WILLIAM BATESON, M.A., F.R.S., PRESIDENT OF THE SECTION.

IN choosing a subject for this address I have availed myself of the kindly usage which permits a sectional president to divert the attention of his hearers into those lines of inquiry which he himself is accustomed to pursue. Nevertheless, in taking the facts of breeding for my theme, I am sensible that this privilege is subjected to a certain strain.

Heredity—and variation too—are matters of which no naturalist likes to admit himself entirely careless. Everyone knows that, somewhere hidden among the phenomena denoted by these terms, there must be principles which, in ways untraced, are ordering the destinies of living things. Experiments in heredity have thus, as I am told, a universal fascination. All are willing to offer an outward deference to these studies. The limits of that homage, however, are soon reached, and, though all profess interest, few are impelled to make even the moderate mental effort needed to apprehend what has been already done. It is understood that heredity is an important mystery, and variation another mystery. The naturalist, the breeder, the horticulturist, the sociologist, man of science and man of practice alike, has daily occasion to make and to act on assumptions as to heredity and variation, but many seem well content that such phenomena should remain for ever mysterious.

The position of these studies is unique. At once fashionable and neglected, nominally the central common ground of botany and zoology, of morphology and physiology, belonging specially to neither, this area is thinly tenanted. Now, since few have leisure for topics with which they cannot suppose themselves concerned, I am aware that, when I ask you in your familiar habitations to listen to tales of a no man's land, I must forego many of those supports by which a speaker may maintain his hold on the intellectual sympathy of an audience.

Those whose pursuits have led them far from their companions cannot be exempt from that differentiation which is the fate of isolated groups. The stock of common knowledge and common ideas grows smaller until the difficulty of inter-communication becomes extreme. Not only has our point of view changed, but our materials are unfamiliar, our methods of inquiry new, and even the results attained accord little with the common expectations of the day. In the progress of sciences we are used to be led from the known to the unknown, from the half-perceived to the proven, the expectation of one year becoming the certainty of the next. It will aid appreciation of the change coming over evolutionary science if it be realised that the new knowledge of heredity and variation rather replaces than extends current ideas on those subjects.

Convention requires that a president should declare all well in his science; but I cannot think it a symptom indicative of much health in our body that the task of assimilating the new knowledge has proved so difficult. An eminent foreign professor lately told me that he believed there were not half a dozen in his country conversant with what may be called Mendelism, though he added hopefully, "I find these things interest my students more than my colleagues." A professed biologist cannot afford to ignore a new life-history, the Okapi, or the other last new version of the old story; but phenomena which put new interpretations on the whole, facts witnessed continually by all who are working in these fields, he may conveniently disregard as matters of opinion. Had a discovery comparable in magnitude with that of Mendel been announced in physics or in chemistry, it would at once have been repeated and extended in every great scientific school throughout the world. We could come to a British Association audience to discuss the details of our subject—the polymorphism of extracted types, the physiological meaning of segregation, its applicability to the case of sex, the nature of non-segregable characters, and like problems with which we are now dealing—sure of finding sound and helpful criticism; nor would it be necessary on each occasion to begin with a popular presentation of the rudiments. This state of things in a progressive science has arisen, as I think, from a loss of touch with the main line of inquiry. The successes of descriptive zoology are so palpable and so attractive, that, not unnaturally, these which are the means of progress have been mistaken for the end. But now that the survey of terrestrial types by existing methods is happily approaching completion, we may hope that our science will return to its proper task, the detection of the fundamental nature of living things. I say *return*, because, in spite of that perfecting of the instruments of research characteristic of our time, and an extension of the area of scrutiny, the last generation was nearer the main quest. No one can study the history of biology without perceiving that in some essential respects the spirit of the naturalists of fifty years ago was truer in aim, and that their methods of inquiry were more direct and more fertile—so far, at least, as the problem of evolution is concerned—than those which have replaced them.

If we study the researches begun by Kölreuter and continued with great vigour until the middle of the sixties, we cannot fail to see that had the experiments he and his successors undertook been continued on the same lines, we should by now have advanced far into the unknown. More than this: if a knowledge of what those men actually accomplished had not passed away from the memory of our generation, we should now be able to appeal to an informed public mind, having some practical acquaintance with the

phenomena, and possessing sufficient experience of these matters to recognise absurdity in statement and deduction, ready to provide that healthy atmosphere of instructed criticism most friendly to the growth of truth.

Elsewhere I have noted the paradox that the appearance of the work of Darwin, which crowns the great period in the study of the phenomena of species, was the signal for a general halt. The "Origin of Species," the treatise which for the first time brought the problem of species fairly within the range of human intelligence, so influenced the course of scientific thought that the study of this particular phenomenon—specific difference—almost entirely ceased. That this was largely due to the simultaneous opening up of lines of research in many other directions may be granted; but in greater measure, I believe, it is to be ascribed to the substitution of a conception of species which, with all the elements of truth it contains, is yet barren and unnatural. It is not wonderful that those who held that specific difference must be a phenomenon of slowest accumulation, proceeding by steps needing generations for their perception, should turn their attention to subjects deemed more amenable to human enterprise.

The indiscriminate confounding of all divergences from type into one heterogeneous heap under the name "Variation" effectually concealed those features of order which the phenomena severally present, creating an enduring obstacle to the progress of evolutionary science. Specific normality and distinctness being regarded as an accidental product of exigency, it was thought safe to treat departures from such normality as comparable differences: all were "variations" alike. Let us illustrate the consequences. Princess of Wales is a large modern violet, single, with stalks a foot long or more. Marie Louise is another, with large double flowers, pale colour, short stalks, peculiar scent, leaf, &c. We call these "varieties," and we speak of the various fixed differences between these two, and between them and wild *odorata*, as due to variation; and, again, the transient differences between the same *odorata* in poor, dry soil, or in a rich hedge-bank, we call variation, using but the one term for differences, quantitative or qualitative, permanent or transitory, in size, number of parts, chemistry, and the rest. We might as well use one term to denote the differences between a bar of silver, a stick of lunar caustic, a shilling, or a teaspoon. No wonder that the ignorant tell us they can find no order in variation.

This prodigious confusion, which has spread obscurity over every part of these inquiries, is traceable to the original misconception of the nature of specific difference, as a thing imposed and not inherent. From this, at least, the earlier experimenters were free; and the undertakings of Gärtner and his contemporaries were informed by the true conception that the properties and behaviour of species were themselves specific. Free from the later fancy that but for selection the forms of animals and plants would be continuous and indeterminate, they recognised the definiteness of species and variety, and boldly set themselves to work out case by case the manifestations and consequences of that definiteness.

Over this work of minute and largely experimental analysis, rapidly growing, the new doctrine that organisms are mere conglomerates of adaptative devices descended like a numbing spell. By an easy confusion of thought, faith in the physiological definiteness of species and variety passed under the common ban which had at last exorcised the demon Immutability. Henceforth no naturalist must hold communion with either, on pain of condemnation as an apostate, a danger to the dynasty of Selection. From this oppression we in England, at least, are scarcely beginning to emerge. Bentham's "Flora," teaching very positively that the primrose, the cowslip, and the oxlip are impermanent varieties of one species, is in the hand of every beginner, while the British Museum Reading Room finds it unnecessary to procure Gärtner's "*Bastarderzeugung.*"

And so this mass of specific learning has passed out of account. The evidence of the collector, the horticulturist, the breeder, the fancier, has been treated with neglect, and sometimes, I fear, with contempt. That wide field whence Darwin drew his wonderful store of facts has been some forty years untouched. Speak to professional zoologists of any breeder's matter, and how many will not intimate to you politely that fanciers are unscientific persons, and their concerns beneath notice? For the concrete in evolution we are offered the abstract. Our philosophers debate with great fluency whether between imaginary races sterility could grow up by an imaginary Selection; whether Selection working upon hypothetical materials could produce sexual differentiation; how under a system of Natural Selection bodily symmetry may have been impressed on formless protoplasm—that monstrous figment of the mind, fit starting-point for such discussions. But by a physiological irony enthusiasm for these topics is sometimes fully correlated with indifference even to the classical illustrations; and for many whose minds are attracted by the abstract problem of inter-racial sterility there are few who can name for certain ten cases in which it has been already observed.

And yet in the natural world, in the collecting-box, the seed-bed, the poultry-yard, the places where variation, heredity, selection may be seen in operation and their properties tested, answers to these questions meet us at every turn—fragmentary answers, it is true, but each direct to the point. For if anyone will stoop to examine Nature in those humble places, will do a few days' weeding, prick out some rows of cabbages, feed up a few score of any variable larva, he will not wait long before he learns the truth about variation. If he go further and breed two or three generations of almost any controllable form, he will obtain immediately facts as to the course of heredity which obviate the need for much laborious imagining. If strictly trained, with faith in the omnipotence of selection, he will not proceed far before he encounters disquieting facts. Upon whatever character the attention be fixed, whether size, number, form of the whole or of the parts, proportion, distribution of differentiation, sexual characters, fertility, precocity or lateness, colour, susceptibility to cold or to disease—in short, all the kinds of characters which we think of as best exemplifying specific difference—we are certain to find illustrations of the occurrence of departures from normality, presenting exactly the same definiteness elsewhere characteristic of normality itself. Again and again the circumstances of their occurrence render it impossible to suppose that these striking differences are the product of continued selection, or, indeed, that they represent the results of a gradual transformation of any kind. Whenever by any collocation of favouring circumstances such definite novelties possess a superior viability, supplanting their "normal" relatives, it is obvious that new types will be created.

The earliest statement of this simple inference is, I believe, that of Marchant,[1] who in 1719, commenting on certain plants of Mercurialis with laciniated and hair-like leaves, which for a time established themselves in his garden, suggested that species may arise in like manner. Though the same conclusion has appeared inevitable to many, including authorities of very diverse experience, such as Huxley, Virchow, F. Galton, it has been strenuously resisted by the bulk of scientific opinion, especially in England. Lately, however, the belief in Mutation, as De Vries has taught us to call it, has made notable progress,[2] owing to the publication of his splendid collection of observations and experiments, which must surely carry conviction of the reality and abundance of Mutation to the minds of all whose judgments can be affected by evidence.

That the dread test of Natural Selection must be passed by every aspirant to existence, however brief, is a truism which needs no special proof. Those who find satisfaction in demonstrations of the obvious may amply indulge themselves by starting various sorts of some annual, say French poppy, in a garden, letting them run to seed, and noticing in a few years how many of the finer sorts are represented; or by sowing an equal number of seeds taken from several varieties of carnation, lettuce, or auricula, and seeing in what proportions the fine kinds survive in competition with the common.

Selection is a true phenomenon; but its function is to *select*, not to create. Many a white-edged poppy may have germinated and perished before Mr. Wilks saved the

[1] Marchant, *Mém. Ac. roy. des Sci.* for 1719; 1721, p 59, Pls. 6–7. I owe this reference to Coutagne, "L'hérédité chez les vers à soie" (*Bull. sci. Fr. Belg.* 1902).

[2] This progress threatens to be rapid indeed. Since these lines were written Prof. Hubrecht, in an admirable exposition (*Pop. Sci. Monthly*, July, 1904) of De Vries' "Mutations-theorie," has even blamed me for having ten years ago attached *any* importance to continuous variation. Nevertheless, when the unit of segregation is small, something mistakably like continuous evolution must surely exist. (Cp. Johannsen, "Ueb. Erblichkeit in Populationen und in reinen Linien," 1903.)

individual which in a few generations gave rise to the Shirleys. Many a black *Amphidasys betularia* may have emerged before, some sixty years ago, in the urban conditions of Manchester the black var. *doubledayaria* found its chance, soon practically superseding the type in its place of origin, extending itself over England, and reappearing even in Belgium and Germany.

Darwin gave us sound teaching when he compared man's selective operations with those of Nature. Yet how many who are ready to expound Nature's methods have been at the pains to see how man really proceeds? To the domesticated form our fashions are what environmental exigency is to the wild. For years the conventional Chinese primrose threw sporadic plants of the loose-growing *stellata* variety, promptly extirpated because repugnant to mid-Victorian primness. But when taste, as we say, revived, the graceful Star Primula was saved by Messrs. Sutton, and a stock raised which is now of the highest fashion. I dare assert that few botanists meeting *P. stellata* in Nature would hesitate to declare it a good species. This and the Shirleys precisely illustrate the procedure of the raiser of novelties. His operations start from a definite beginning. As in the case of *P. stellata*, he may notice a mutational form thrown off perfect from the start, or, as in the Shirleys, what catches his attention may be the first indication of that flaw which if allowed to extend will split the type into a host of new varieties each with its own peculiarities and physiological constitution.

Let anyone who doubts this try what he can do by selection without such a definite beginning. Let him try from a pure strain of black and white rats to raise a white one by breeding from the whitest, or a black one by choosing the blackest. Let him try to raise a dwarf ("Cupid") sweet pea from a tall race by choosing the shortest, or a crested fowl by choosing the birds with most feather on their heads. To formulate such suggestions is to expose their foolishness.

The creature is beheld to be very good after, not before its creation. Our domesticated races are sometimes represented as so many incarnations of the breeder's prophetic fancy. But except in recombinations of pre-existing characters—now a comprehensible process—and in such intensifications and such finishing touches as involve variations which analogy makes probable, the part played by prophecy is small. Variation leads; the breeder follows. The breeder's method is to notice a desirable novelty, and to work up a stock of it, picking up other novelties in his course—for these genetic disturbances often spread—and we may rest assured the method of Nature is not very different.

The popular belief that evolution, whether natural or artificial, is effected by mass-selection of impalpable differences arises from many errors which are all phases of one—imperfect analysis—though the source of the error differs with the circumstances of its exponent. When the scientific advocate professes that he has statistical proofs of the continuity of variation, he is usually availing himself of that comprehensive use of the term Variation to which I have referred. Statistical indications of such continuity are commonly derived from the study, not of nascent varieties, but of the fluctuations to which all normal populations are subject. Truly varying material needs care in its collection, and if found is often sporadic or in some other way unsuitable for statistical treatment. Sometimes it happens that the two phenomena are studied together in inextricable entanglement, and the resulting impression is a blur.

But when a practical man, describing his own experience, declares that the creation of his new breed has been a very long affair, the man of science, feeling that he has found a favourable witness, puts forward this testimony as conclusive. But on cross-examination it appears that the immense period deposed to seldom goes back beyond the time of the witness's grandfather, covering, say, seventy years; more often ten, or eight, or even five years will be found to have accomplished most of the business. Next, in this period—which, if we take it at seventy years, is a mere point of time compared with the epochs of which the selectionist discourses—a momentous transformation has often been effected, not in one character but many. Good characters have been added, it may be, of form, fertility, precocity, colour, and other physiological attributes, undesirable qualities have been eliminated, and all sorts of defects "rogued" out. On analysis these operations can be proved to depend on a dozen discontinuities. Be it, moreover, remembered that within this period, besides *producing* his mutational character and combining it with other characters (or it may be groups of characters), the breeder has been working up a *stock*, reproducing in quantity that quality which first caught his attention, thus converting, if you will, a phenomenon of individuals into a phenomenon of a mass, to the future mystification of the careless.

Operating among such phenomena the gross statistical method is a misleading instrument; and, applied to these intricate discriminations, the imposing Correlation Table into which the biometrical Procrustes fits his arrays of unanalysed data is still no substitute for the common sieve of a trained judgment. For nothing but minute analysis of the facts by an observer thoroughly conversant with the particular plant or animal, its habits and properties, checked by the test of crucial experiment, can disentangle the truth.

To prove the reality of Selection as a factor in evolution is, as I have said, a work of supererogation. With more profit may experiments be employed in defining the *limits* of what Selection can accomplish. For whenever we can advance no further by Selection, we strike that hard outline fixed by the natural properties of organisms. We come upon these limits in various unexpected places, and to the naturalist ignorant of breeding nothing can be more surprising or instructive.

Whatever be the mode of origin of new types, no theoretical evolutionist doubts that Selection will enable him to fix his character when obtained. Let him put his faith into practice. Let him set about breeding canaries to win in the class for Clear Yellow Norwich at the Crystal Palace Show. Being a selectionist, his plan will be to pick up winning yellow cocks and hens at shows and breed them together. The results will be disappointing. Not getting what he wants, he may buy still better clear yellows and work them in, and so on until his funds are exhausted, but he will pretty certainly breed no winner, be he never so skilful. For no selection of winning yellows will make them into a breed. They must be formed afresh by various combinations of colours appropriately crossed and worked up. Though breeders differ as to the system of combinations to be followed, all would agree that selection of birds representing the winning type was a sure way to fail. The same is true for nearly all canary colours except in Lizards, and, I believe, for some pigeon and poultry colours also.

Let this scientific fancier now go to the Palace Poultry Show and buy the winning Brown Leghorn cock and hen, breed from them, and send up the result of such a mating year after year. His chance of a winner is not quite, but almost, *nil*. For in its wisdom the fancy has chosen one type for the cock and another for the hen. They belong to distinct strains. The hen corresponding to the winning cock is too bright, and the cock corresponding to the winning hen is too dull for the judge's taste. The same is the case in nearly every breed where the sex-colours differ markedly. Rarely winners of both sexes have come in one strain—a phenomenon I cannot now discuss—but the contrary is the rule. Does anyone suppose that this system of "double mating" would be followed, with all the cost and trouble it involves, if Selection could compress the two strains into one? Yet current theory makes demands on Selection to which this is nothing.

The tyro has confidence in the power of Selection to fix type, but he never stops to consider what fixation precisely means. Yet a simple experiment will tell him. He may go to a great show and claim the best pair of Andalusian fowls for any number of guineas. When he breeds from them he finds, to his disgust, that only about half their chickens, or slightly more, come blue at all, the rest being blacks or splashed whites. Indignantly, perhaps, he will complain to the vendor that he has been supplied with no selected breed, but worthless mongrels. In reply he may learn that beyond a doubt his birds come from blues only in the direct line for an indefinite number of generations, and that to throw blacks and splashed whites is the inalienable property of blue Andalusians. But now let him breed from his "wasters," and he will find that the extracted blacks are *pure* and give blacks only, that the splashed whites similarly give only whites or splashed whites—but if the two sorts of "wasters" are crossed together *blues only* will result.

Selection will never make the blues breed true; nor can this ever come to pass unless a blue be found the germ-cells of which are bearers of the blue character—which may or may not be possible. If the selectionist reflect on this experience he will be led straight to the centre of our problem. There will fall, as it were, scales from his eyes, and in a flash he will see the true meaning of fixation of type, variability, and mutation, vaporous mysteries no more.

Owing to the unhappy subdivisions of our studies, such phenomena as these—constant companions of the breeder—come seldom within the purview of modern science, which, forced for a moment to contemplate them, expresses astonishment and relapses into indolent scepticism. It is in the hope that a little may be done to draw research back into these forgotten paths that I avail myself of this great opportunity of speaking to my colleagues with somewhat wider range of topic than is possible within the limits of a scientific paper. For I am convinced that the investigation of heredity by experimental methods offers the sole chance of progress with the fundamental problems of evolution.

In saying this I mean no disrespect to that study of the physiology of reproduction by histological means, which, largely through the stimulus of Weismann's speculations, has of late made such extraordinary advances. It needs no penetration to see that, by an exact knowledge of the processes of maturation and fertilisation, a vigorous stock is being reared, upon which some day the experience of the breeder will be firmly grafted, to our mutual profit. We, who are engaged in experimental breeding, are watching with keenest interest the researches of Strasburger, Boveri, Wilson, Farmer, and their many fellow-workers and associates in this difficult field, sure that in the near future we shall be operating in common. We know already that the experience of the breeder is in no way opposed to the facts of the histologist; but the point at which we shall unite will be found when it is possible to trace in the maturing germ an indication of some character afterwards recognisable in the resulting organism. Until then, in order to pursue directly the course of heredity and variation, it is evident that we must fall back on those tangible manifestations which are to be studied only by field observation and experimental breeding.

The breeding-pen is to us what the test-tube is to the chemist—an instrument whereby we examine the nature of our organisms and determine empirically what for brevity I may call their genetic properties. As unorganised substances have their definite properties, so have the several species and varieties which form the materials of our experiments. Every attempt to determine these definite properties contributes immediately to the solution of that problem of problems, the physical constitution of a living organism. In those morphological studies which I suppose most of us have in our time pursued, we sought inspiration from the belief that in the examination of present normalities we were tracing the past, the phylogenetic order of our types, the history—as we conceived—of Evolution. In the work which I am now pressing upon your notice we may claim to be dealing not only with the present and the past, but with the future also.

On such an occasion as this it is impossible to present to you in detail the experiments—some exceedingly complex—already made in response to this newer inspiration. I must speak of results, not of methods. At a later meeting, moreover, there will be opportunities of exhibiting practically to those interested some of the more palpable illustrations. It is also impossible to-day to make use of the symbolic demonstrations by which the lines of analysis must be represented. The time cannot be far distant when ordinary Mendelian formulæ will be mere *as in praesenti* to a biological audience. Nearly five years have passed since this extraordinary re-discovery was made known to the scientific world by the practically simultaneous papers of De Vries, Correns, and Tschermak, not to speak of thirty-five years of neglect endured before. Yet a phenomenon comparable in significance with any that biological science has revealed remains the intellectual possession of specialists. We still speak sometimes of Mendel's hypothesis or theory, but in truth the terms have no strict application. It is no theory that water is made up of hydrogen and oxygen, though we cannot watch the atoms unite, and it is no theory that the blue Andalusian fowl I produce was made by the meeting of germ-cells bearing respectively black and a peculiar white. Both are incontrovertible facts deduced from observation. The two facts have this in common also, that their perception gives us a glimpse into that hidden order out of which the seeming disorder of our world is built. If I refer to Mendelian "theory," therefore, in the words with which Bacon introduced his Great Instauration, "I entreat men to believe that it is not an opinion to be held, but a work to be done; and to be well assured that I am labouring to lay the foundation, not of any sect or doctrine, but of human utility and power."

In the Mendelian method of experiment the one essential is that the posterity of each *individual* should be traced separately. If individuals from necessity are treated collectively, it must be proved that their composition is identical. In direct contradiction to the methods of current statistics, Mendel saw by sure penetration that masses must be avoided. Obvious as this necessity seems when one is told, no previous observer had thought of it, whereby the discovery was missed. As Mendel immediately proved in the case of peas, and as we have now seen in many other plants and animals, it is often impossible to distinguish by inspection individuals whose genetic properties are totally distinct. Breeding gives the only test.

Segregation.

Where the proper precautions have been taken, the following phenomena have been proved to occur in a great range of cases, affecting many characters in some thirty plants and animals. The qualities or characters the transmission of which in heredity is examined are found to be distributed among the germ-cells, or gametes, as they are called, according to a definite system. This system is such that these characters are treated by the cell-divisions (from which the gametes result) as existing in pairs, each member of a pair being alternative or *allelomorphic* to the other in the composition of the germ. Now, as every zygote—that is, any ordinary animal or plant—is formed by the union of two gametes, it may either be made by the union of two gametes bearing similar members of any pair, say two blacks or two whites, in which case we call it *homozygous* in respect of that pair, or the gametes from which it originates may be bearers of the dissimilar characters, say a black and a white, when we call the resulting zygote *heterozygous* in respect of that pair. If the zygote is homozygous, no matter what its parents or their pedigree may have been, it breeds true indefinitely unless some fresh variation occurs.

If, however, the zygote be heterozygous, or gametically cross-bred, its gametes in their formation separate the allelomorphs again, so that each gamete contains only one allelomorphic character of each pair. At least one cell-division in the process of gametogenesis is therefore a differentiating or *segregating* division, out of which each gamete comes sensibly pure in respect of the allelomorph it carries, exactly as if it had not been formed by a heterozygous body at all. That, translated into modern language, is the essential discovery that Mendel made. It has now been repeated and verified for numerous characters of numerous species, and, in face of heroic efforts to shake the evidence or to explain it away, the discovery of gametic segregation is, and will remain, one of the lasting triumphs of the human mind.

In extending our acquaintance of these phenomena of segregation we encounter several principal types of complication.

Segregation Absent or Incomplete.—From our general knowledge of breeding we feel fairly well satisfied that true absence of segregation is the rule in certain cases. It is difficult, for instance, to imagine any other account of the facts respecting the American Mulattos, though even here sporadic occurrence of segregation seems to be authenticated. Very few instances of genuine absence of segregation have been critically studied. The only one I can cite from my own experience is that of *Pararge egeria* and *egeriades*, "climatic" races of a butterfly. When crossed together, they give the common intermediate type of North-Western France, which, though artificially formed, breeds in great measure true. This crossed back with either type has given, as a rule, simple blends between intermediate and type. My evidence is not, however, complete enough to

warrant a positive statement as to the total absence of segregation, for in the few families raised from pairs of artificial intermediates some dubious indications of segregation have been seen.

The rarity of true failure of segregation when pure strains are crossed may be judged by the fact that since the revival of interest in such work hardly any thoroughly satisfactory cases have been witnessed. The largest body of evidence on this subject is that provided by De Vries. These cases, however, present so many complexities that it is impossible to deal with them now. While so little is definitely known regarding non-segregating characters, it appears to me premature to attempt any generalisation as to what does or does not segregate.

Most of the cases of failure of segregation formerly alleged are evidently spurious, depending on the appearance of homozygotes in the second generation (F_2).

One very important group of cases exists, in which the appearance of a *partial* failure of segregation after the second generation (F_2) is really due to another phenomenon. The visible character of a zygote may, for instance, depend on the coexistence in it of two characters belonging to distinct allelomorphic pairs, each capable of being independently segregated from its fellow, and forming independent combinations. For the demonstration of this important fact we are especially indebted to Cuénot.[1] We have indications of the existence of such a phenomenon in a considerable range of instances (mice, rabbits (Hurst), probably stocks and sweet peas).

Nevertheless, there are other cases, not always easy to distinguish from these, where *some* of the gametes of F_1 certainly carry on heterozygous characters unsegregated. As an example, which seems to me indisputable, I may mention the so-called "walnut" comb, normal to Malay fowls. This can be made artificially by crossing rose-comb with pea-comb, and the cross-bred then forms gametes, of which one in four bears the compound unsegregated.[2] We may speak of this as a true *synthesis*.

In another type of cases segregation occurs, but is not sharp. The gametes may then represent a full series ranging from the one pure form to the other. Such cases occur in regard to some colours of *Primula sinensis*, and the leg-feathering of fowls (Hurst). In the second generation a nearly complete series of intermediate zygotes may result, though the two pure extremes (if the case be one of blending characters) may still be found to be pure.

Resolution and Disintegration.—Besides these cases, the features of which we now in great measure comprehend, we encounter frequently a more complex segregation, imperfectly understood, by which gametes of new types, sometimes very numerous, are produced by the crossbred. Each of these new types has its own peculiarities. We shall, I think, be compelled to regard these phenomena as produced either by a *resolution* of compound characters introduced by one or both parents, or by some process of *disintegration*, effected by a breaking-up of the integral characters followed by recombinations. It seems impossible to imagine simple recombinations of pre-existing characters as adequate to produce many of these phenomena. Such a view would involve the supposition that the number of characters pre-existing as units was practically infinite—a difficulty that as yet we are not obliged to face. However that may be, we have the fact that resolutions and disintegrations of this kind—or recombinations, if that conception he preferred—are among the common phenomena following crossing, and are the sources of most of the breeder's novelties. As bearing on the theoretical question to which I have alluded, we may notice that it is among examples of this complex breaking-up that a great proportion of the cases of partial sterility have been seen.

No quite satisfactory proof as to the actual moment of segregation yet exists, nor have we any evidence that all characters are segregated at the same cell-division. Correns has shown that in maize the segregation of the starch character from the sugar character must happen before the division forming the two generative nuclei, for both bear the same character. The reduction-division has naturally been suggested as the critical moment. The most serious difficulty in accepting this view, as it seems to me, is the fact that somatic divisions appear sometimes to segregate allelomorphs, as in the case of Datura fruits, and some colour-cases.

In concluding this brief notice of the complexities of segregation I may direct attention to the fact that we are here engaged in no idle speculation. For it is now possible by experimental means to distinguish almost always with which phenomenon we are dealing, and each kind of complication may be separately dealt with by a determination of the properties of the extracted forms. Illustrations of a practical kind will be placed before you at a subsequent meeting.

The consequence of segregation is that in cases where it occurs we are rid of the interminable difficulties which beset all previous attempts to unravel heredity. On the older view, the individuals of any group were supposed to belong to an indefinite number of classes, according to the various numerical proportions in which various types had entered into their pedigree. We now recognise that when segregation is allelomorphic, as it constantly is, the individuals are of three classes only in respect of each allelomorphic pair—two homozygous and one heterozygous. In all such cases, therefore, fixity of type, instead of increasing gradually generation by generation, comes suddenly, and is a phenomenon of individuals. Only by the separate analysis of individuals can this fact be proved. The supposition that progress towards fixity of type was gradual arose from the study of masses of individuals, and the gradual purification witnessed was due in the main to the gradual elimination of impure individuals, whose individual properties were wrongly regarded as distributed throughout the mass.

We have at last the means of demonstrating the presence of integral characters. In affirming the integrity of segregable characters we do not declare that the size of the integer is fixed eternally, as we suppose the size of a chemical unit to be. The integrity of our characters depends on the fact that they *can* be habitually treated as units by gametogenesis. But even where such unity is manifested in its most definite form, we may, by sufficient searching, generally find a case where the integrity of the character has evidently been impaired in gametogenesis, and where one such individual is found the disintegration can generally he propagated. That the size of the unit may be changed by unknown causes, though a fact of the highest significance in the attempt to determine the physical nature of heredity, does not in the least diminish the value of the recognition of such units, or lessen their part in governing the course of Evolution.

The existence of unit-characters had, indeed, long been scarcely doubtful to those practically familiar with the facts of variation (*cp.* De Vries, "Intracellulare Pangenesis," 1889), but it is to the genius of Mendel that we owe the proof. We knew that characters could behave as units, but we did not know that this unity was a phenomenon of gametogenesis. He has revealed to us the underworld of gametes. Henceforth, whenever we see a preparation of germ-cells we shall remember that, though all may look alike, they may in reality be of many and definite kinds, differentiated from each other according to regular systems.

Numerical Relations of Gametes and their Significance.

In addition to the fact of segregation, Mendel's experiments proved another fact nearly as significant; namely, that when characters are allelomorphic, the gametes bearing each member of a pair generally are formed in equal numbers by the heterozygote, if an average of cases be taken. This fact can only be regarded as a consequence of some numerical symmetry in the cell-divisions of gametogenesis We already know cases where individual families

[1] When *abc* . . . $\times$ *αβγ* . . . gives in F_1 or F_2 a character (not seen in the original parents), which from F_2 or later may breed true: not because *aα*, *bβ*, *cγ* do not severally segregate, but through simultaneous homozygosis of, say, *aa* and *ββ*, giving a zygote *aaββcγ* . . . which will breed true to the character *aβ*.

[2] Owing to this behaviour, and to the simultaneous production of single-comb (? by resolution), there are, even in pure Malays, five types of individuals, all with "walnut" combs—as yet indistinguishable—formed by gametic unions $r \times p$, $rp \times rp$, $rp \times r$, $rp \times p$, $rp \times s$. Of these kinds three can at once be distinguished by crossing with single; but whether $r \times p$ can be distinguished from $rp \times s$ we do not yet know. [*r*, rose; *p*, pea; *s*, single; *rp* walnut.] In this example four allelomorphs are simultaneously segregated, one being compound. Neglecting sexual differentiation, there are therefore *ten* gametically distinct types theoretically possible; but of these only *four* are distinguishable by inspection.

show such departure from normal expectation that either the numbers produced must have been unequal, or subsequent disturbance must have occurred. But so far no case is known *for certain* where the average of families does not point to equality.

The fact that equality is so usual has a direct bearing on conceptions of the physical nature of heredity. I have compared our segregation with chemical separation, but the phenomenon of numerically symmetrical disjunction as a feature of so many and such different characters seems scarcely favourable to any close analogy with chemical processes. If each special character owed its appearance to the handing on of some complex molecule as a part of one chemical system, we should expect, among such a diversity of characters and forms of life, to encounter some phenomenon of valency, manifested as numerical inequality between members of allelomorphic pairs. So far, equivalence is certainly the rule, and where the characters are simply paired and no resolution has taken place, this rule appears to be universal as regards averages. On the other hand, there are features in the distribution of characters after resolution, when the second generation (F_2) is polymorphic in a high degree, which are not readily accounted for on any hypothesis of simple equivalence; but none of these cases are as yet satisfactorily investigated.

It is doubtful whether segregation is rightly represented as the separation of *two* characters, and whether we may not more simply imagine that the distinction between the allelomorphic gametes is one of presence or absence of some distinguishing element. De Vries has devoted much attention to this question in its bearings on his theory of Pangenesis, holding that cases of both kinds occur, and attempting to distinguish them. Indications may certainly be enumerated pointing in either direction, but for the present I incline to defer a definite opinion.

If we may profitably seek in the physical world for some parallel to our gametic segregations, we shall, I think, find it more close in mechanical separations, such as those which may be effected between fluids which do not freely mix, than in any strictly chemical phenomenon. In this way we might roughly imitate both the ordinary segregation, which is sensibly perfect, and the curious impurity occasionally perceptible even in the most pronounced discontinuities, such as those which divide male from female, petal from sepal, albino from coloured, horn from hair, and so on.

Gametic Unions and their Consequences.

Characters being then distributable among gametes according to regular systems, the next question concerns the properties and features presented by the zygotes formed by the union of gametes bearing different characters.

As to this no rule can as yet be formulated. Such a heterozygote may exhibit one of the allelomorphic characters in its full intensity (even exceeding it in special cases, perhaps in connection with increased vigour), or it may be intermediate between the two, or it may present some character not recognisable in either parent. In the latter case it is often, though not always, reversionary. When one character appears in such intensity as to conceal or exclude the other it is called *dominant*, the other being *recessive*. It may be remarked that frequently, but certainly not universally (as has been stated), the phylogenetically older character is dominant. A curious instance to the contrary is that of the peculiar arrangement of colours seen in a breed of game fowls called Brown-breasted, which in combination with the purple face, though certainly a modern variation, dominates (most markedly in females) over the Black-breasted type of *Gallus bankiva*.

In a few cases irregularity of dominance has been observed as an exception. The clearest illustration I can offer is that of the extra toe in fowls. Generally this is a dominant character, but sometimes, as an exceptional phenomenon, it may be recessive, making subsequent analysis very difficult. The nature of this irregularity is unknown. A remarkable instance is that of the blue colour in maize seeds (Correns; R. H. Lock). Here the dominance of blue is frequently imperfect, or absent, and the figures suggest that some regularity in the phenomenon may be discovered.

Mendel is often represented as having enunciated dominance as a general proposition. That this statement should still be repeated, even by those who realise the importance of his discoveries, is an extraordinary illustration of the oblivion that has overwhelmed the work of the experimental breeders. Mendel makes the specific statement in regard to certain characters in peas which do behave thus, but his proposition is not general. To convict him of such a delusion it would be necessary to prove that he was exceptionally ignorant of breeding, though on the face of the evidence he seems sufficiently expert.

A generalisation respecting the consequences of heterozygosis possessing greater value is this. When a pair of gametes unites in fertilisation the characters of the zygote depend directly on the constitution of these gametes, and not on that of the parents from which they came. To this generalisation we know as yet only two clear exceptions. These very curious cases are exactly alike in that, though segregation obviously occurs in a seed-character, the seeds borne by the hybrid (F_1) all exhibit the hybrid character, and the consequences of segregation in the particular seed-character are not evident until the seeds (F_3) of the second (F_2) generation are determinable. Of these the first is the case of indent peas investigated especially by Tschermak. Crossed with wrinkled peas I have found the phenomena normal, but when the cross is made with a round type the exceptional phenomenon occurs. The second case is that discovered by Biffen in the cross between the long-grained wheat called Polish and short-grained Rivett wheat, demonstrations of which will be laid before you. No satisfactory account of these peculiarities has been yet suggested, but it is evident that in some unexplained way the maternal plant-characters control the seed-characters for each generation. It is, of course, likely that other comparable cases will be found.

Appearances have been seen in at least four cases (rats, mice, stocks, sweet peas) suggesting at first sight that a heterozygosis between two gametes, *both* extracted, may give, *e.g.*, dominance; while if one, or both, were pure, they would give a reversionary heterozygote. If this occurrence is authenticated on a sufficient scale, we shall of course recognise that the fact proves the presence in these cases of some pervading and non-segregating quality, distributed among the extracted gametes formed by the parent heterozygote. As yet, however, I do not think the evidence enough to warrant the conclusion that such a pervading quality is really present, and I incline to attribute the appearances to redistribution of characters belonging to independent pairs in the manner elucidated by Cuénot. The point will be easily determined, and meanwhile we must note the two possibilities.

Following, therefore, our first proposition, that the gametes belong to definite classes, comes the second proposition, that the unions of members of the various classes have specific consequences. Nor is this proposition simply the truistical statement that different causes have different effects; for by its aid we are led at once to the place where the different cause is to be sought—Gametogenesis. While formerly we hoped to determine the offspring by examining the *ancestry* of the parents, we now proceed by investigating the *gametic composition* of the parents. Individuals may have identical ancestry (and sometimes, to all appearances, identical characters), but yet be quite different in gametic composition; and, conversely, individuals may be identical in gametic composition and have very different ancestry. Nevertheless, those that are identical in gametic composition are the same, whatever their ancestry. Therefore, where such cases are concerned, in any considerations of the physiology of heredity, ancestry is misleading and passes out of account. To take the crudest illustration, if a hybrid is made between two races, A, B, and another hybrid between two other races, C, D, it might be thought that when the two hybrids AB and CD are bred together, four races, A, B, C, and D, will be united in their offspring. This expectation may be entirely falsified, for the cell-divisions of gametogenesis may have split A from B and C from D, so that the final product may contain characters of only two races after all, being either AC, BC, AD, or BD. In practice, however, we are generally dealing with *groups* of characters, and the union of all the A group, for instance, with all the C group will be a rare coincidence.

It is the object of Mendelian analysis to state each case of heredity in terms of gametic composition, and thence to

determine the laws governing the distribution of characters in the cell-divisions of gametogenesis.

There are, of course, many cases which still baffle our attempts at such analysis, but some of the most paradoxical exceptions have been reduced to order by the accumulation of facts. The consequences of heterozygosis are curiously specific, and each needs separate investigation. A remarkable case occurred in stocks, showing the need for caution in dealing with contradictory results. Hoary leaves and glabrous leaves are a pair of allelomorphic characters. When glabrous races were crossed with crossbreds, sometimes the results agreed with simple expectation, while in other cases the offspring were all hoary when, in accordance with similar expectation, this should be impossible. By further experiment, however, Miss Saunders has found that *certain* glabrous races crossed together give nothing but hoary heterozygotes, which completely elucidates such exceptions. There is every likelihood that wherever segregation occurs similar analysis will be successful.

Speaking generally, in every case the first point to be worked out is the magnitude of the character-units recognised by the critical cell-divisions of gametogenesis, and the second is the specific consequence of all the possible combinations between them. When this has been done for a comprehensive series of types and characters, it will be time to attempt further generalisation, and perhaps to look for light on that fundamental physiological property, the power of cell-division.

Segregation and Sex.—Acquaintance with Mendelian phenomena irresistibly suggests the question whether in *all* cases of families composed of distinct types the distinctness may not be primarily due to gametic segregation. Of all such distinctions none is so universal or so widespread as that of sex: may it not be possible that sex is due to a segregation occurring between gametes, either male, female, or both? It will be known to you that several naturalists have been led by various roads to incline to this view. We still await the proof of crucial experiments; but without taking you over more familiar ground, it may be useful to show how the matter looks from our standpoint. As regards actual experiment, all results thus far are complicated by the occurrence of some sterility in the hybrid generation. Correns, fertilising ♀ *Bryonia dioica* with pollen from ☿ *B. alba*, obtained offspring (F_1) *either* ♂ or ♀, with only one doubtful exception. Gärtner found a similar result in *Lychnis diurna* ♀ × ☿ *L. Flos-cuculi* as ♂, but only raised six plants (4 ♂, 2 ♀). From *L. diurna* ♀ × ☿ *Silene noctiflora* as ♂ he got only two plants, spoken of as females which developed occasional anthers. These results give a distinct suggestion that sex may be determined by differentiation among the male gametes, but satisfactory and direct proofs can only be obtained from some case where sterility does not ensue.

Apart, however, from such decisive evidence—which, indeed, would be more satisfactory if relating to *animals*—several circumstances suggest that sex is a segregation-phenomenon. Prof. Castle in a valuable essay has directed attention to distinct evidence of disturbance in the heredity of certain moths (*Aglia tau* and *lugens*, Standfuss's experiments; *Tephrosia*, experiments of Bacot and others, summarised by Tutt),[1] where the disturbance is pretty certainly connected with sexual differentiation. Mr. Punnett and I are finding suggestions of the same thing in certain poultry cases. Mr. Doncaster has pointed out that the evidence of Mr. Raynor clearly indicates that a certain variety of *Abraxas grossulariata*, usually peculiar to the female, is a Mendelian recessive. It is scarcely doubtful that this will be shown to hold also for some other female varieties, *e.g.*, *Colias edusa*, var. *helice*, &c. We can therefore feel no doubt that there is some entanglement between sex and gametically segregable characters. A curious instance of a comparable nature is that of the Cinnamon canary (Norduijn, &c.), and similar complications are alleged as regards the descent of colour-blindness and hæmophilia.

In one remarkable group of facts we come very near to the phenomenon of sex. Experiments made in conjunction with Mr. R. P. Gregory have shown that the familiar heterostylism of Primula is a phenomenon of Mendelian segregation. Short style, or "thrum," is a dominant—

[1] *Trans. Ent. Soc. Lond.*, 1898.

with a complication;[1] long style, or "pin," is recessive; while equal, or "homostyle," is recessive to both.

Even nearer we come in a certain sweet-pea example, where abortion of anthers behaves as an ordinary Mendelian recessive character.[2] By a slight exaggeration we might even speak of a hermaphrodite with barren anthers as a "female."

Consider also how like the two kinds of differentiation are. The occasional mosaicism in Lepidoptera, called "gynandromorphism," may be exactly paralleled by specimens where the two halves are two colour-varieties, instead of the two sexes. Patches of *Silene inflata* in this neighbourhood commonly consist of hairy and glabrous individuals,[3] a phenomenon proved in Lychnis to be dependent on Mendelian segregation. The same patch consists also of female plants and hermaphrodite plants. Is it not likely that both phenomena are similar in nature? How otherwise would the differentiation be maintained? The sweet-pea case I have spoken of is scarcely distinguishable from this. I therefore look forward with confidence to the elucidation of the real nature of sex—that redoubtable mystery.

We now move among the facts with an altogether different bearing. "Animals and Plants under Domestication," from being largely a narration of inscrutable prodigies, begins to take shape as a body of coherent evidence. Of the old difficulties many disappear finally. Others are inverted. Darwin says he would have expected "from the law of reversion" that nectarines being the newer form would more often produce peaches than peaches nectarines, which is the commoner occurrence. Now, on the contrary, the unique instance of the Carclew nectarine tree bearing peaches is more astonishing than all the other evidence together!

Though the progress which Mendelian facts make possible is so great, it must never be forgotten that as regards new characters involving the addition of some new factor to the pre-existing stock we are almost where we were. When they have been added by mutation, we can now study their transmission; but we know not whence or why they come. Nor have we any definite light on the problem of adaptation; though here there is at least no increase of difficulties.

Besides these outstanding problems, there remain many special points of difficulty which on this occasion I cannot treat—curiosities of segregation, obscure aberrations of fertilisation[4] (occasionally met with), coupling of characters, and the very serious possibility of disturbance through gametic selection. Let us employ the space that remains in returning to the problem of variation, already spoken of above, and considering how it looks in the light of the new facts as to heredity. The problem of heredity is the problem of the manner of distribution of characters among germ-cells. So soon as this problem is truly formulated, the nature of variation at once appears. For the first time in the history of evolutionary thought, Mendel's discovery enables us to form some picture of the process which results in genetic variation. It is simply the segregation of a new kind of gamete, bearing one or more characters distinct from those of the type. We can answer one of the oldest questions in philosophy. In terms of the ancient riddle, we may reply that the Owl's egg existed before the Owl; and if we hesitate about the Owl, we may be sure about the Bantam. The parent zygote, the offspring of which display variation, is giving off new gametes, and in its gametogenesis a segregation of their new character, more or less

[1] It is doubtful if "thrum" ever breeds true, as both the other types can do. Perhaps "thrum" is a *Halbrasse* of De Vries.

[2] Neglecting minor complications, the descent is as follows:—Lady Penzance ♀ × Emily Henderson (long pollen) ♂ gave purple F_1. In one F_2 family, with rare exceptions, *coloured* plants with *dark* axils were fertile, those with *light* axils having ♂ sterile, whites being either fertile or sterile. The ratios indicated are 9 coloured, dk. ax., fertile ♂ : 3 coloured, lt. ax., sterile ♂ : 3 white, fertile ♂ : 1 white, sterile ♂. The fertile whites, therefore, though light-axilled (as whites almost always are), presumably bear the dark-axil character, which generally cannot appear except in association with coloured flowers. This can be proved next year. Some at least of the plants with sterile ♂ are fertile on the ♀ side, and when crossed with a coloured light-axilled type will presumably give only light-axilled plants.

[3] This excellent illustration was shown me by Mr. A. W. Hill and Mr. A. Wallis. A third form, glabrous, with hairy edges to the leaves, also occurs.

[4] In view of Ostenfeld's discovery of parthenogenesis in *Hieracium*, the possibility that this phenomenon plays a part in some non-segregating cases needs careful examination.

pure, is taking place. The significance and origin of the discontinuity of variation is therefore in great measure evident. So far as pre-existing elements are concerned, it is an expression of the power of cell-division to distribute character-units among gametes. The initial purity of so many nascent mutations is thus no longer surprising, and, indeed, that such initial purity has not been more generally observed we may safely ascribe to imperfections of method.

It is evident that the resemblance between the parent originating a variety and a heterozygote is close, and the cases need the utmost care in discrimination. If, for instance, we knew nothing more of the Andalusian fowl than that it throws blacks, blues, and whites, how should we decide whether the case was one of heterozygosis or of nascent mutation? The second (F_2) generation from Brown Leghorn × White Leghorn contains an occasional Silver-Grey or Duckwing female. Is this a *mutation* induced by crossing, or is it simply due to a recombination of pre-existing characters? We cannot yet point to a criterion which will certainly separate the one from the other; but perhaps the statistical irregularity usually accompanying mutation, contrasted with the numerical symmetry of the gametes after normal heterozygosis, may give indications in simple cases—though scarcely trustworthy even there. These difficulties reach their maximum in the case of types which are *continually* giving off a second form with greater or less frequency as a concomitant of their ordinary existence. This extraordinarily interesting phenomenon, pointed out first by De Vries, and described by him under the head of "*Halb-*" and "*Mittel-Rassen*," is too imperfectly understood for me to do more than refer to it, but in the attempt to discover what is actually taking place in variation it must play a considerable part.

Just as that normal truth to type, which we call heredity, is in its simplest elements only an expression of that qualitative symmetry characteristic of all non-differentiating cell-divisions, so is genetic variation the expression of a qualitative asymmetry beginning in gametogenesis. Variation is a novel cell-division.[1] So soon as this fact is grasped we shall hear no more of heredity and variation as opposing "factors" or "forces"—a metaphor which has too long plagued us.

We cease, then, to wonder at the suddenness with which striking variations arise. Those familiar with the older literature relating to domesticated animals and plants will recall abundant instances of the great varieties appearing early in the history of a race, while the finer shades had long to be waited for. In the sweet pea the old purple, the red bicolor, and the white have existed for generations, appearing soon after the cultivation of the species; but the finer splitting which gave us the blues, pinks, &c., is a much rarer event, and for the most part only came when crossing was systematically undertaken. If any of these had been seen before by horticulturists, we can feel no doubt whatever they would have been saved. An observer contemplating a full collection of modern sweet peas, and ignorant of their history, might suppose that the extreme types had resulted from selective and more or less continuous intensification of these intermediates, exactly inverting the truth.

We shall recognise among the character-groups lines of cleavage, along which they easily divide, and other finer subdivisions harder to effect. Rightly considered, the sudden appearance of a total albino or a bicolor should surprise us less than the fact that the finer shades can appear at all.

At this point comes the inevitable question, what *makes* the character-group split? Crossing, we know, may do this; but if there be no crossing, what is the *cause* of variation? With this question we come sharply on the edge of human knowledge. But certain it is that if causes of variation are to be found by penetration, they must be specific causes. A mad dog is not "caused" by July heat, nor a moss rose by progressive culture. We await our Pasteur; founding our hope of progress on the aphorism of Virchow, that every variation from type is due to a pathological accident, the true corollary of "*Omnis cellula e cellula.*"

[1] The parallel between the differentiating divisions by which the parts of the normal body are segregated from each other, and the segregating processes of gametogenesis, must be very close. Occasionally we even see the segregation of Mendelian characters among zygotic cells.

In imperfect fashion I have now sketched the lines by which the investigation of heredity is proceeding, and some of the definite results achieved. We are asked sometimes, Is this new knowledge of any use? That is a question with which we, here, have fortunately no direct concern. Our business in life is to find things out, and we do not look beyond. But as regards heredity, the answer to this question of use is so plain that we may give it without turning from the way.

We may truly say, for example, that even our present knowledge of heredity, limited as it is, will be found of extraordinary use. Though only a beginning has been made, the powers of the breeder of plants and animals are vastly increased. Breeding is the greatest industry to which science has never yet been applied. This strange anomaly is over; and, so far at least as fixation or purification of types is concerned, the breeder of plants and animals may henceforth guide his operations with a great measure of certainty.

There are others who look to the science of heredity with a loftier aspiration; who ask, Can any of this be used to help those who come after to be better than we are—healthier, wiser, or more worthy? The answer depends on the meaning of the question. On the one hand it is certain that a competent breeder, endowed with full powers, by the aid even of our present knowledge, could in a few generations breed out several of the morbid diatheses. As we have got rid of rabies and pleuro-pneumonia so we could exterminate the simpler vices. Voltaire's cry, "*Écraser l'infâme!*" might well replace Archbishop Parker's Table of Forbidden Degrees, which is all the instruction Parliament has so far provided. Similarly, a race may conceivably be bred true to some physical and intellectual characters considered good. The positive side of the problem is less hopeful, but the various species of mankind offer ample material. In this sense science already suggests the way. No one, however, proposes to take it; and so long as, in our actual laws of breeding, superstition remains the guide of nations, rising ever fresh and unhurt from the assaults of knowledge, there is nothing to hope or to fear from these sciences.

But if, as is usual, the philanthropist is seeking for some external application by which to ameliorate the course of descent, knowledge of heredity cannot help him. The answer to his question is *No*, almost without qualification. We have no experience of any means by which transmission may be made to deviate from its course; nor from the moment of fertilisation can teaching, or hygiene, or exhortation pick out the particles of evil in that zygote, or put in one particle of good. From seeds in the same pod may come sweet peas climbing five feet high, while their own brothers lie prone upon the ground. The stick will not make the dwarf peas climb, though without it the tall can never rise. Education, sanitation, and the rest, are but the giving or withholding of opportunity. Though in the matter of heredity every other conclusion has been questioned, I rejoice that in this we are all agreed.

NOTES.

THE sum of 120*l*. has been granted by the Paris Municipal Council to Prof. Grancher in furtherance of his researches as to the means of preventing tuberculosis in schools.

ON Monday and Tuesday, September 12 and 13, a visit is to be paid to London by a large party of Belgian engineers, members of the Association des ingénieurs sortis de l'Ecole de Liège—one of the most important technical societies on the Continent. The party will be the guests of the Iron and Steel Institute.

PROF. APPELL, dean of the faculty of sciences in the University of Paris, has had the civil title of commandeur de la Légion d'honneur conferred upon him by the French Minister of War. Prof. Appell has served for some time on the commission appointed to examine inventions likely to be of service to the French Army and Navy.

THE *Gazette* of August 23 gives notice that by the Wireless Telegraphy Act, 1904, it is provided that a person shall not establish any wireless telegraph station or instal or work any apparatus for wireless telegraphy in any place in the British Isles or on board any British ship in the territorial waters abutting on the coast of the British Isles except under and in accordance with a licence granted in that behalf by the Postmaster-General. Wireless telegraphy is defined by the Act to mean any system of communication by telegraph as defined in the Telegraph Acts, 1863 to 1904, without the aid of any wire connecting the points from and at which the messages or other communications are sent and received.

THE death is announced of Dr. George Pirie, professor of mathematics in the University of Aberdeen.

DR. HANS BATTERMANN, astronomer at the Berlin Observatory, has been appointed director of the observatory and professor of astronomy at Königsberg.

THE *Athenaeum* announces the death of the well known German geographer, Prof. F. Ratzel, at the age of sixty. Since 1886 he had been professor at the University of Leipzig.

THE twenty-third annual summer meeting of the English Arboricultural Society took place last week at Aberdeen, when Prof. Fisher, of the R.I.E. College, Coopers Hill, was elected president for the ensuing year.

AN international exhibition of hygiene, life-saving, first aid, and of industrial arts has been opened at the Grand Palais des Champs Elysées in Paris by the French Minister of Commerce, M. Georges Trouillot. The exhibition will be open until November.

THE first International Congress of Education and Home Protection of Infants will be held in September of next year in Liège in connection with the Universal Exposition at that place. There will be four sections in all, devoted to the following subjects:—(1) Study of childhood; (2) education of children (*a*, general questions; *b*, education by parents at home; *c*, collaboration of the family with the school; *d*, education in the family after the school period); (3) abnormal children; (4) various lines of work relative to childhood.

ACCORDING to the *Scotsman*, Mr. Eagle Clarke, of the Natural History Department of the Edinburgh Museum of Science and Art, will, by permission of the Commissioners of Northern Lights, spend some time during the coming autumn in the lighthouse on the Flannan Islands for the purpose of studying the migratory movements of birds. Since the lighthouse was erected on this outlying group a few years ago it has been ascertained that the islands lie in the course of a considerable stream of migratory birds *en route* between their northern spring and southern winter quarters, a fact which is of special interest owing to the far westerly situation of the isles, and one which renders it very desirable that the phenomena observed there should be investigated by an expert. Mr. Clarke will also investigate the limited terrestrial fauna and flora of the islands, which, owing to their remote situation and the difficulty of landing on them, have not hitherto received attention.

IN a recently published pamphlet entitled "An Introduction to the Study of Forestry in Britain," Sir Harold G. Hewett, Bart., makes an appeal in favour of the so-called new school of forestry, that is, scientific forestry as it is understood and taught on the Continent. In the author's opinion the different works on forestry in the English language recommend methods differing so widely as to bewilder the beginner. The object of this booklet is to criticise, compare, and reconcile where possible the advice given by the several writers. The author strongly advocates the adoption of more scientific methods in the treatment of British woodlands, the existing methods being too haphazard and antiquated.

IN celebrating its twenty-seventh annual excursion, the Royal Scottish Arboricultural Society visited France, where a fortnight was spent inspecting the various types of forests and studying the different methods of forest management as practised there. Three centres were chosen, where the society in turn established its headquarters. The party, numbering seventy members, proceeded first to Nancy, where the forest school and neighbouring forests belonging to the State were inspected. After spending several days in Nancy, the excursionists proceeded to Gerardmer, with the object of inspecting the coniferous forest of the Vosges Mountains. During the few days' sojourn in Gerardmer, the party had an opportunity of making a trip on the electric railway to the summit of the Schlucht, the highest point of the French Vosges, which reaches an altitude almost equal to that of Ben Nevis. During the ascent many interesting observations were made on the character of the trees and other vegetation according to altitude. On nearing the wind-swept summit, the forest trees became reduced to mere bushes and scrub. From Gerardmer the party then proceeded to Paris, where headquarters were established for the last week of the excursion, when the forests of Villiers Cotterêts, Compiègne, and Bellême were visited, which afforded many valuable object lessons in the treatment of beech and oak woods.

WE have received the report of the Meteorological Service of Canada for the year 1902, containing monthly and annual summaries for a large number of stations, including some in Newfoundland and one in Bermuda. Most of the telegraphic reports are forwarded to the weather bureau at Washington, which office in return supplies the Canadian Service with some sixty-eight reports from the United States, affording data for a very comprehensive daily weather chart, and for the issue of weather forecasts for all parts of the Dominion lying to the eastward of the Rocky Mountains. The percentage of success of these forecasts in each district is given for each month and for the year, and the general total reaches the high figure of 86·6. The predictions partly verified are divided by two before being added to the total percentage, which makes the figure quoted even more successful than appears at first sight. The storm warnings attain still higher success; 88 per cent. were fully, and 95 per cent. were fully and partially, verified. We congratulate the director, Mr. R. F. Stupart, on these very satisfactory results.

A NUMBER of papers dealing with experimental progress in the direction of aërial navigation have reached us during the last few months. As long ago as November last an illustrated account of the Barton airship was given in the *Automotor Journal*. Among other peculiarities we notice the use of aëroplanes for raising and lowering the balloon, the introduction of water tanks for maintaining a level keel, and the peculiar form of the propellers, each of which consists of three pairs of blades fixed one behind the other, thus embodying in the propeller the principle of superposed narrow vanes which has been so successfully applied to aëroplanes. In the *Revue scientifique* (5), i., 2, M. Jean Jaubert gives an account of the aëroplane machine constructed by Mr. Ernest Archdeacon at Berck-sur-Mer (France). A paper communicated to the American Associ-

ation last year by Mr. Octave Chanute, contained a general account of recent progress in aërial navigation; this paper appeared in the *Popular Science Monthly* for March. Still more recently Captain Ferber, of the French Artillery, has brought out reprints of a paper from the *Revue d'Artillerie*, published by Berger-Levrault, of Paris, dealing mainly with gliding flight. Captain Ferber's own experiments were first conducted with pure gliding machines of the same type as those of the brothers Wright, but for his later experiments he has procured a mechanically propelled machine carrying a six horse-power motor, and weighing only 230 kilograms. Instead of experimenting in free air, Captain Ferber has adopted the principle of the captive machine, his machine being attached to a revolving arm 30 metres long supported on a pillar 18 metres high. This aërodrome is after the designs of MM. Goupil and Bazin.

IN the *Bulletin* of the Johns Hopkins Hospital (xv., No. 159, June) Dr. Percy Dawson gives an interesting biography of the Rev. Stephen Hales. The name of this great Englishman is familiar to every student of physiology as the first discoverer of the blood pressure, which he demonstrated by connecting a glass tube, now called the "Hales manometer," with an artery, and noting the rise of the blood within it. In addition, Hales contributed many papers on ventilation and natural history to the *Philosophical Transactions* of the Royal Society.

CAPTAIN GEO. LAMB, I.M.S., contributes a second communication on the specificity of anti-venomous sera to the *Scientific Memoirs of the Government of India* (No. 10, 1904; see NATURE, vol. lxviii. p. 395). He details experiments performed with two anti-venomous sera, one prepared with the venom of the *Hoplocephalus curtus* (tiger snake), the other with that of the cobra, these two sera being tested against the poisons of eight other snakes, including the king cobra, two kraits, common Indian sea snake, daboia, green pit viper, and Californian rattlesnake. Against the king cobra venom the cobra anti-serum had a slight neutralising effect, but not marked; as regards other venoms it had practically no neutralising power. The same holds good for the tiger snake anti-serum; while powerfully antitoxic for tiger snake venom, it is practically inactive against other venoms. These results confirm Captain Lamb's, and also Dr. Tidswell's, former observations that anti-venomous sera are strictly specific, and are active only against the venoms used to prepare them.

TWO out of the three articles in the May number of the *American Naturalist* are devoted to botanical subjects, Prof. Penhallow continuing in the one his account of the anatomy of North American conifers, while in the second Dr. B. M. Davis commences a study of the structure of the vegetable cell. In the one zoological article, Dr. A. Hrdlička gives further examples of a division in the malar bone of the skull in man and monkeys.

IN the *Biologisches Centralblatt* for August Mr. G. Klebs continues his studies of the problem of development, as exemplified by the lowest plants, while Mr. C. Schaposchnikow offers a new explanation for the presence of a red coloration in the hind-wings of the butterflies of the genus Catocala. The red-winged Catocalas, as the author remarks, are restricted to the Holarctic region, and this distribution is of itself sufficient to indicate that their peculiar type of coloration is connected with their environment.

FIVE out of the six articles in the July issue of the *Quarterly Journal of Microscopical Science* are devoted to invertebrate morphology and anatomy. In the first of these Mr. E. S. Goodrich describes a remarkable arrangement in the branchial vascular system of the worm Sternapsis, by means of which the blood has an alternative path to the normal one, leading from the main dorsal to the main ventral vessel. In a second Dr. E. J. Allen describes the anatomy of the annelid Pœcilochætus, while in a third Dr. Herbert Fowler communicates notes on *Rhabdopleura normani*, an ally of Balanoglossus. A paper on the anatomy and affinities of the molluscs of the family Trochidæ, by Mr. W. B. Randles, and one on a sporozoan parasite found in the mouse, by Mr. H. M. Woodcock, complete the invertebrate list. Special interest attaches to an article by Mr. G. Smith on the middle ear and columella in birds. As the result of observations carried on at a very early stage of development, the author concludes that, while the stapes of birds and reptiles (Sauropsida) represents the same bone in mammals, the other parts of the auditory region have undergone a different development in the two groups. It may be noticed that Mr. Smith makes no mention of Dr. Broom's recent provisional identification of the inter-articular cartilage of Ornithorhynchus with the quadrate.

DR. J. P. THOMSON, secretary of the Queensland branch of the Royal Geographical Society of Australasia, contributes a paper on Queensland to the *Geographical Journal*. Dr. Thomson gives a very clear picture of the geography of north-eastern Australia, and we commend his paper to the notice of teachers.

WE have received a copy of a valuable paper issued by the Norwegian "Gradmaalings-Kommission" on the tides of the Norwegian coast. Analyses and discussion of extended observations at a number of stations are given, chiefly with the view of separating the two different systems of Atlantic and North Sea origin, and treating the complex interference phenomena observed off the southern extremity of Norway.

IN the *Bibliotheca mathematica*, v. 2, Prof. Gino Loria, of Genoa, gives an account of the life and works of the late Prof. Luigi Cremona, accompanied by a portrait and a chronological list of Prof. Cremona's writings.

THE theory of Maxwell and wireless telegraphy, by Prof. H. Poincaré, form the subject of the twenty-third volume of the physico-chemical series of *Scientia*, published by Messrs. Carré and Naud, of Paris. It appears to be an extension of the first volume of the series by the addition of chapters dealing with the principles and applications of wireless telegraphy.

WE have received a reprint of a lecture delivered by M. Maurice d'Ocagne at the Conservatoire des Arts et Métiers, having the title "Les instruments de précision en France." It contains a description of the more refined instruments in use at the Bureau international des Poids et Mesures, in the principal observatories in France, and in the French military survey.

UNDER the title of "Malerbriefe," Prof. Ostwald has published through the house of Hirzel, Leipzig, a series of seventeen short and suggestive essays on the theory and practice of painting. Though this slight brochure can scarcely add anything to the reputation of the distinguished author, it furnishes another example of the versatility of his genius.

AN instructive series of lantern slides illustrating waves and kindred forms of the atmosphere, hydrosphere, and lithosphere has been collected by Dr. Vaughan Cornish for Messrs. Newton and Co. The collection includes the

most interesting pictures shown by Dr. Cornish at the Royal Geographical Society and elsewhere, and the descriptive notes which have been prepared for the slides direct attention to the chief points of interest.

We have received from New York the first number of the *Mining Magazine*, an international monthly review of progress in mining and metallurgy. Though new in name, the magazine is really a development of the *Pacific Coast Miner*, a weekly journal of repute. It is edited by specialists, and the illustrations and typography reach the high standard that characterises American magazines. The contents are of varied interest. Mr. J. A. Church gives a sketch of mining, past and future. The geographical distribution of ores within the United States is discussed by Mr. F. L. Ransome. Mr. Carl Henrich gives an admirably illustrated account of the Guanajuato mining district of Mexico; and Mr. Henry S. Fleming discusses the commercial divisions of the competitive coal markets. Lastly, a useful index of current literature is provided.

OUR ASTRONOMICAL COLUMN.

VISIBILITY OF THE MARTIAN CANALS.—In *Bulletin* No. 12 of the Lowell Observatory Mr. Lowell extends and sums up the results recently outlined by him in a communication to the American Academy of Sciences under the title "The Cartouches of the Canals of Mars." During the last opposition he made 372 drawings of the planet's visible surface on 143 nights, and by carefully examining these and eliminating all known extrinsic variations he secured sufficient data to enable him to plot a visibility curve for each canal, between January 19 and July 26, which he believes exhibits only the actual, intrinsic variability of the marking in question. This curve he calls the "cartouche" of that canal.

Analysing the 109 curves thus obtained he finds, except in three cases, a well marked seasonal variation. These curves are not exactly similar, but on arranging them in a steadily progressive order it was seen that the order was one of latitude, the increase of visibility taking place in the north polar canals first and in the equatorial canals last. The reason assigned for the earlier quickening of the polar canals is that all these markings are due to vegetable growth, which requires both warm sunshine and water for its increase, and, as the general surface of Mars is devoid of water, this growth has to await the arrival of the liberated fluid from the polar caps before it can assume its vernal appearance. Naturally, the sun having already passed the summer solstice, those portions of the planet's surface nearer to the water supply will be the first to grow the new vegetation.

Further considerations, dealt with *in extenso* in the *Bulletin*, lead Mr. Lowell to the conclusion that both the anomalies and the generalities he has discovered argue for the artificial origin of the Martian canals.

TOTAL SOLAR ECLIPSE OF 1905.—An article in the August number of the *Bulletin de la Société astronomique de France* gives a number of details concerning the eclipse of 1905, and maps showing the entire path and the sections of it which traverse Spain and Tunis. A set of diagrams showing the appearance, at various places, of the greatest phase of the eclipse, indicates that for Paris the eclipse commences at 12h. 3·1m. (Paris Civil M.T.), has its greatest phase (0·818) at 13h. 19·1m., and finishes at 14h. 31·7m.

SOLAR PROMINENCES DURING 1903.—In No. 6, vol. xxxiii., of the *Memorie della Società degli Spettroscopisti Italiani*, Prof. Mascari summarises the results of the observations of prominences made at Catania during 1903.

Very few prominences were seen during the first months of the year, but they were notably augmented later. In January and February the phenomena presented themselves with equal intensity in each hemisphere, but in the second and third trimestres they prevailed in the northern hemisphere, whilst in the fourth they were more numerous in southern latitudes.

The number of days without prominences during 1903 was 38 per cent. of the total number of days of observation, instead of 67 per cent. as in 1902. The mean latitude of the prominences in 1903 was 42°·1, as compared with 48°·4 in the previous year. The undecennial minimum of prominence activity apparently occurred in October, 1902.

THE LOWELL SPECTROGRAPH.—In No. 1, vol. xx., of the *Astrophysical Journal*, Mr. V. M. Slipher gives a detailed description of the complete spectrographic equipment obtained for the Lowell Observatory from Mr. J. A. Brashear in 1901.

The chief instrument differs but little from the Mills spectrograph (Lick), and its linear and angular dispersion at Hγ, as compared with the other large instruments of its class, may be seen from the following table:—

Spectrograph		Focal length of camera mm.	Dispersion: Linear, tenth-metres per mm.	Dispersion: Angular, for one-tenth metre ″
Lowell	Short	386	14·5	36·8
,, ...	Long	471	11·4	36·8
Mills (Lick) ...		406	12·6	40·5
Potsdam III....	1	560	10·2	36·5
,, ...	2	410	13·8	36·5
Bruce (Yerkes)	A	449	10·7	42·8
,,	B	607	7·9	42·8

Mr. Slipher's communication gives all the details of the instrument's construction and mounting, and is illustrated by several photographs and colour-curves.

A NEW BAND SPECTRUM OF NITROGEN.—Whilst photographing the spectrum of the afterglow from metallic spark discharges in an atmosphere of nitrogen, Mr. Percival Lewis, of the University of California, has discovered what is presumably a new band spectrum of nitrogen. He found that the afterglow occurred only in chemically prepared, dried and purified nitrogen, and then only when a strong condenser discharge was employed.

The spectrum is discontinuous, consisting of lines and bands, some of the latter belonging to Deslandre's third group, whilst others were of unknown origin. No afterglow occurred in the metallic vapours unless there was an afterglow in the gas. New bands occur in most of the spectra obtained at λλ 2750, 2890, 3035, and 3200, whilst others, at approximate wave-lengths 3380, 3575, 3805, 4130, and 4540, only occur in some of the photographs. Of the latter bands several may be due to NO, but none of them are found in the spectrum of NO_2 (*Astrophysical Journal*, No. 1, vol. xx.).

THE PERSEID METEORIC SHOWER OF 1904.

THIS shower has not furnished a rich display this year; in fact, the number of meteors visible appears to have been decidedly below the average. Yet there was no moonlight to offer any impediment, and the nights were very clear just at the important time.

On August 9 there were a few Perseids, but the meteors recorded from all sources little exceeded the average number observable on an ordinary night in August, and I wrote down in my notebook that I had never seen so few meteors on August 9 in any previous year.

On August 10 there was an increase in the number visible, but I made no lengthy observations.

On August 11, between 10h. 30m. and 13h. 30m., Perseids were falling at the rate of about 25 per hour for one observer, and the radiant was at 46°+58° from 37 paths. This horary rate is for an observer who registered a few of the tracks, and whose attention, therefore, was not given continuously to the sky. Mr. McHarg at Lisburn, Ireland, says that from 10h. to 11h. local time the Perseids averaged 30 to the hour. Mr. J. Webb, of Bristol, counted 21 between 9h. 50m. and 10h. 50m.; Mr. W. E. Besley, of London, saw 66 meteors in 3 hours between 10h. 30m. and 13h. 30m., and others must have been missed while records were being made. He saw meteors as bright as Jupiter or Venus at 10h. 30m., 11h. 14m., 11h. 20m., and 13h. 7m. Mr. McHarg noted a brilliant green fireball > ♀ at 10h. 20m. G.M.T. falling in Libra a little west of α and directed from ε Boötis, so it was probably a Perseid.

On August 12 the Perseids were again in evidence, but not very abundantly. At Bristol between 10h. and 12h. 30m. there were about 17 or 20 per hour, but the watch was not quite continuous. The radiant was very sharply defined at $47^\circ + 58^\circ$ from about 20 paths.

On August 13 the sky was less favourable; there was a good deal of haze, and the stars were blurred and faint; only a few Perseids were seen in these adverse circumstances.

Though the shower generally was not a plentiful one, it is likely to prove interesting in some of its results, for a number of its meteors appear to have been observed at more than one station, and their real paths can be computed.

Three features in reference to the shower of 1904 appear to the writer to deserve special mention:—

(1) The sharply defined point of radiation on August 11 and 12.

(2) The comparatively meagre character of the display.

(3) The fact that nearly all the Perseids appeared on the right (western side) of the radiant. This was very marked, and the writer has been struck with the same peculiarity in preceding years. There were many Perseids in Andromeda, Pegasus, Cassiopeia, Cepheus, and Cygnus, but few in Camelopardus, Auriga, the Lynx, and Ursa Major.

W. F. Denning.

THE THIRD INTERNATIONAL CONGRESS OF MATHEMATICIANS.

THERE are few towns better suited for a scientific gathering than Heidelberg, and few scientific gatherings have passed off so successfully as the third International Mathematical Congress which met there from August 8 to 13. The number of mathematicians attending the congress was 330, giving with holders of ladies' tickets a total membership of nearly 400. The German Government, the Grand Duke of Baden, the municipal and university authorities of Heidelberg, the Deutsche Mathematiker Vereinigung, and an influential executive committee all joined in giving the congress a hearty welcome, and the local arrangements were perfect.

The formal proceedings opened on Tuesday, August 9, under the presidency of Prof. H. Weber, of Strasburg. The year 1904 being the centenary of the birth of Jacobi, the occasion was selected for the delivery of an address by Prof. Leo Königsberger on Jacobi's life and works. A large volume by Prof. Königsberger dealing with the same subject was published by Messrs. Teubner in connection with the present commemorations.

Another feature of the congress was the presentation, by Prof. Klein, of the first copy of vol. i. of the "Encyklopädie der matematischen Wissenschaften," which volume has just been completed. Considerable progress was also reported in the preparation of the French edition of the "Encyklopädie."

Prof. Gutzmer, of Jena, presented a history of the Deutsche Mathematiker Vereinigung, founded in 1890, as well as the July part of the *Jahresbericht* of the society, containing papers on the teaching of mathematics.

Passing on to a review of the work done in the sectional and general meetings, the most noticeable feature revealed by the general spirit in which many of the papers were written was the growing tendency in the mathematical world to devote greater attention to the practical and experimental aspects of mathematics, especially in connection with mathematical teaching. From such signs as this it appears not unlikely that we are on the eve of a renaissance period in the history of mathematics. A large collection of models, mathematical instruments, apparatus, and books was exhibited in the large hall of the museum. Prof. Runge, of Hanover, exhibited and described Leibnitz's calculating machine. A number of experiments on fluid motion past various boundaries were shown by Prof. Prandtl, of the same town. These differed from Prof. Hele-Shaw's experiments with thin films in that a vessel of some depth (say an inch or two) was used, and water or liquid of small viscosity employed; in this case a series of vortices were seen to be thrown off in succession from a cylindrical or other obstacle, and the various stages of formation of each vortex were clearly demonstrated by photographs as well as experimentally.

Prof. Greenhill's discourse on the theory of the top, considered historically, also contained an attempt to give graphical representations of the motion of the top, and was illustrated by experiments with bicycle wheels and other equally simple apparatus.

Coming to matters of more purely educational interest, Prof. Klein, in his address to the applied mathematics section, gave an amusing account of the methods in vogue in certain German middle schools for obviating the use of the calculus, a state of affairs reminding one of the old Cambridge "three days." Prof. Loria, of Genoa, stated that the attempt to abolish Euclid in Italy had failed owing to the badness of the text-books brought out to meet the new conditions, that a Government prize had been in consequence offered for a good manual on geometry, and that the books of Veronese, Enriques, Amaldi, Paolis and others were the result.

Prof. Gutzmer urged that elasticity and thermodynamics should form part of the training of every professor of applied mathematics. Resolutions were passed by the congress urging the Government to provide models and projection-lanterns for use in teaching mathematics in the German schools and technical colleges. A further resolution related to the teaching of geometrical drawing in schools.

In connection with the historical section, a resolution was passed relating to the publication of Euler's works by the Carnegie Institution. Prof. Schlesinger announced the appearance of the first volume of the works of L. Fuchs, and a bibliography of Wronski's works was presented by Prof. S. Dickstein.

Of papers in applied mathematics, the most remarkable was Prof. Sommerfeld's investigation on the motion of electrons; the remaining papers dealt *inter alia* with the problem of three bodies (Profs. Delaunay and Levi-Civita), equations of wave motion (Profs. Volterra and Hadamard), attractions (Prof. Genese), and geodesy (Prof. Börsch and others).

In pure mathematics the most striking papers were those by Prof. Hilbert on integral equations and on the foundations of arithmetic, and Prof. König's proof that the continuum cannot be equivalent to any well ordered group. Prof. Painlevé, of Paris, gave an admirable discourse on the integration of differential equations; Prof. Segre, of Turin, on the geometry of to-day; and Prof. Wirtinger, of Vienna, on Riemann's lectures on hypergeometric series. We also note papers by Prof. Schlesinger on Riemann's problem, by Prof. Borel on approximations of continuous functions, and many others too numerous to mention. Prof. E. Study showed that the paradoxical result $2=4$ could be obtained from considerations of intersections of quadric surfaces.

The congress was international in every sense, the membership including representatives of Germany, France, Great Britain, Italy, Switzerland, Austria, Sweden, Denmark, Spain, Russia, Japan, the United States, Greece, and other countries. Only seven of the members present were from Great Britain.

For the meeting place of the next congress in 1908, Rome has been selected, and the congress will take place at a somewhat earlier time of the year (probably about Easter). In this connection a prize is offered for the best thesis on the theory of algebraic gauche curves. It has been decided to hold the next following congress in England.

Not the least important feature of the congress was the large amount of local interest shown in the organisation of social entertainments. On Wednesday, August 10, a dinner was given to all the members in the new Town Hall of Heidelberg. On the Thursday we were received and entertained at Schwetzingen by the Hereditary Grand Duke of Baden. The next evening we sailed down the Neckar in illuminated barges, and on reaching Heidelberg the castle was illuminated by red fire, the proceedings ending with fireworks, including a set-piece of the Pythagorean Theorem (Euc. i., 47). The last evening we were entertained at a concert at the castle, followed by another illumination and a Kommers, for which a special song-book had been published that included a number of amusing mathematical songs written for the occasion. To make this insight into German student life more real, two delegates were elected by the students of German universities to officiate in the uniform of their corps, and with their swords.

The town concerts and many places of interest were specially thrown open to members. The arrangement of meeting places in one or more *cafés* was another feature which added considerably to the social success of the meeting. Excursions were organised to the Stift Neuberg, to Speyer, and up the Neckar Valley.

Mathematicians who had known of one another for years as mere names have now become personal friends, and we shall carry away life-long reminiscences of the many pleasant meetings which have done much to cement the bond of union between fellow workers in all branches of mathematics, and of all nationalities. G. H. BRYAN.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—On Monday, August 22, the University of Cambridge conferred seventeen honorary degrees on the occasion of the meeting of the British Association. The following are the speeches delivered by the Public Orator, Dr. Sandys, of St. John's College, in presenting those of the recipients who received the degree of Doctor in Science for distinction in natural sciences, mathematics, or anthropology:—

OSKAR BACKLUND, PROFESSOR OF ASTRONOMY, ST. PETERSBURG.

Ab exteris exorsi, primum omnium salutamus nuntium quendam sidereum, ab arce illa celeberrima prope Petropolin stellis observandis dedicata ad nos devectum, quae trium deinceps Struviorum nominibus iamdudum gloriatur. Ipse talium virorum haeres dignissimus, planetarum potissimum in moles motusque perturbatos diligenter inquisivit, et Enckii praesertim cometen, ter in quoque decennio inter sidera nostra lucentem, indagandum sibi sumpsit. Dum cometae illius reditum in mense proximo spe certa expectamus, sideris illius indagatorem indefessum hodierni diei inter lumina libenter numeramus.

HENRI BECQUEREL, PROFESSOR OF PHYSICS, PARIS.

Francogallorum e republica vicina cursu prospero ad nos pervenit scientiarum Academiae Parisiensis socius illustris, cuius etiam patrem avumque honore eodem ornatos fuisse constat. Ipse in vi magnetica praesertim exploranda diu praeclare versatus, nuper propterea imprimis famam est adeptus, quod metallum, sideris Urani inventoris in honorem, olim Uranium nominatum, primus omnium nuper probavit ipsum radios quosdam mirabiles emittere, quos etiam per metalla transire non dubitare. Laetamur virum tam illustrem scientiae lumen, a patre suo sibi olim traditum, splendore novo a sese exauctum, etiam aliis invicem iamdudum tradere. Etenim, scientiae quoque in lumine vitali per saecula hominum tradendo,

> "sic rerum summa novatur
> semper, et inter se mortales mutua vivunt,...
> et quasi cursores vitai lampada tradunt."

J. W. BRUEHL, PROFESSOR OF CHEMISTRY, HEIDELBERG.

Salutamus deinceps virum urbis Palatinae inter professores illustres iamdudum numeratum, virum in scientia chemica insignem. Ut rem scientiae illius ad historiam pertinentem paulo altius repetamus, inter physicos antiquos olim, uti nostis, finem secandis corporibus esse negavit quidem Anaxagoras, Democritus autem affirmavit; Democriti vero atomos, per duo milia annorum inutiles et infructuosas existimatas, scientiae chemicae saltem inter professores rursus in honore esse constat. Viri huiusce autem inter merita id potissimum commemoratur, quod, experimentis exquisitis iam per quattuor et viginti annos adhibitis, praeclare ostendit, quae potissimum inter res in unum revera compositas atque atomorum, rerum earum in particula quaque consociatarum, distributionem ratio intercedat. Unde fit, ut etiam in rebus perquam multiplici modo compositis, atomorum illarum nexus accuratius explicentur, atque etiam in coloribus quibusdam novis vetera illa Lucretii verba denuo vera reddita sint, quo docente rerum primordia

> "variis sunt praedi a formis,
> e quibus omne genus gignunt variantque colores
> propterea, magni refert quod semina quaeque
> cum quibus et quali positura contineantur."

ADOLF ENGLER, PROFESSOR OF BOTANY, BERLIN.

Universitatis Berolinensis e professoribus praeclaris adest vir, qui arborum et herbarum provinciam eximiam iam per annos quadraginta luculenter illustravit. Hoc iubente, quot arborum genera conifera, quot liliorum varietates, quot dicotyledonum species obscurae, e tenebris in lucem novam surrexerunt! Idem (ne plura commemorem) etiam scientiae suae Acta a se condita iam per annos tres et viginti edidit, genera plantarum omnia in ordinem optimum reduxit, ne palaeontologiam quidem neglexit, neque Africam Orientalem neque Americam Australem inexploratam reliquit. Quod ad alios attinet, Victoris Hehnii librum celeberrimum de transitu plantarum ex Asia in Europam conscriptum accuratiorem reddidit, etiam plantarum per orbem terrarum distributionem Alexandri Humboldtii in memoriam prosecutus. In scientia botanica nemo fortasse hodie Plinii ipsius verba sibi verius potest arrogare:—" non unius terrae sed totius naturae interpretes sumus."

PAUL VON GROTH, PROFESSOR OF MINERALOGY, MUNICH.

Ex urbe pulcherrima, quod Bavariae totius caput est, ad nos pervenit vir studiorum in regione pulcherrima versatus, qui crystallorum scientiam physicam professus, Milleri nostri, viri insignis, crystallorum describendorum rationem et ipse praetulit et aliis omnibus per Europam totam commendavit. Quantum in scientia sua in ordinem redigenda atque etiam aliis tradenda profuerit, testantur Acta illa ab ipso condita et per annos plus quam quinque et viginti edita; testantur tot discipulorum et amicorum etiam inter exteros gratulationes recentissimae; testatur praeceptoris tanti in honorem imago ipsius arte eximia depicta et anni huius paulo ante Kalendas Maias donata; testatur hodiernus denique dies, quo nomen viri " quem rumor alba gemmeus vehit pinna," tituli nostri signo honorifico consignamus. Etiam hodierni diei memor, poterit fortasse Martialis verba mutuari:—

> "Felix utraque lux, diesque nobis
> Signandi melioribus lapillis."

ALBRECHT KOSSEL, PROFESSOR OF PHYSIOLOGY, HEIDELBERG.

Urbem Palatinam denuo in memoriam vocat physiologiae illius chemicae professor insignis, quae quicquid vivit perscrutata, tot corpuscula textu tenuissima explorat et explicat, tot cellulas absconditas in lucem protrahit et enucleat. Abhinc annos sex eiusdem Universitatis, eiusdem scientiae, professorem in hoc ipso loco laudavimus, qui in unoquoque e tribus decenniis hanc scientiam magnopere adiuvit. In professore illo laudando sperabamus intra proximum decennium fore ut talium virorum laboribus physiologiae in provincia chemica laurus plurimae referentur. Quod illo die sperabamus professoris illius successor feliciter ratum effecit.

HENRY F. OSBORN, PROFESSOR OF ZOOLOGY, NEW YORK.

E republica maxima trans aequor Atlanticum diu prospere constituta laetamur ad nos advectum esse virum palaeontologiae praesertim in scientia insignem, qui non modo in Universitate Columbiana, nobis et linguae et studiorum communium societate coniunctissima, zoologiam praeclare profitetur, sed etiam, Eboraci Novi in Museo maximo, animalium ingentium e rupibus ipsis effossorum multitudinem saxeam, sive Dinosauri sive Atlantosauri nominantur, sive alio aliquo nomine splendido gloriantur, summa sollertia conquisivit, summa arte disposuit, summa cura custodit. Gaudemus rempublicam illam, tot rerum novarum varietate excellentem, etiam vitae pristinae vestigia tam antiqua tanta cum alacritate persequi. Iuvat virum hospitii iure cum plurimis coniunctum Ennii ipsius in verbis etiam propterea laudare, quod, in Museo illo " multa tenens antiqua," ipse " egregie cordatus homo " esse perhibetur.

VITO VOLTERRA, PROFESSOR OF APPLIED MATHEMATICS, ROME.

Quem genuit Ancona, quem arx antiqua Etruriae suo nomine ornavit, quem primum Pisarum, Galilei cum memoria consociatarum, deinde Augustae Taurinorum, denique Romae ipsius Universitas inter professores suos numeravit, multis profecto nominibus observantiae vestrae commendatur. Sed, ut relictis nominibus ad res ipsas progrediamur, inter peritos constat virum hunc lucis praesertim

in legibus investigandis esse imprimis illustrem atque scientiae dynamicae (ut aiunt) in ratione universa exploranda plurimum pollere. Viri Italiae tutius inter mathematicos conspicui meritis accuratius explicandis gravamur prorsus imparem esse veterem illam linguam Latinam, quam ipsa Italia Britannis olim donavit. His saltem in studiis Italia hodierna Italiam antiquam superavit.

Sir David Gill, K.C.B., F.R.S., H.M. Astronomer at the Cape.

Ad patriam reversi, quam libenter salutamus virum in stellis observandis insignem, qui inter Aberdonienses suos astronomiae studia olim auspicatus, planetae Veneris transitum in oceano Indico accurate observandum curavit. Idem et Aegypti et Africae Australis coloniae extremae et Terrae Natalis spatia ampla dimensus est; stellarum omnium imaginum lucis ipsius auxilio reddendarum auctor fuit assiduus; Africae denique in promontorio remotissimo arcem caelestem sibi creditam quinque et viginti per annos fortiter et feliciter occupavit. In excubiis illis patria procul tolerandis quam fortem ipsum, in alios quam generosum sese praestitit; aliorum labores quantis stimulis incitavit, ad exitum felicem perductos quanta benevolentia excepit! Viri talis sub auspiciis et unius e professoribus nostris sub praesidio pro scientiarum societate Britannica in annum proximum Bonae Spei in Promontorio bene nominato licet omnia fausta augurari.

A. W. Howitt, F.G.S., Honorary Fellow of the Anthropological Institute, &c.

Australiae praesertim aborigines, in annos singulos ad minorem numerum redactos, nonnullis vero in locis prope funditus extinctos, simplicitatis pristinae mores antiquos diutissime conservasse constat. Hic autem, a collega optimo, Collegii vicini alumno adiutus, indigenarum illorum primum consuetudines nuptiales, deinde adulescentium initiationes, denique religionis rudimenta prima, diligenter investigavit, et prioris aevi memoriam evanescentem litterarum monumentis fideliter mandavit. Talium virorum laboribus historia, si non "magistra vitae," at certe "lux veritatis," "nuntia vetustatis," "vita memoriae" esse gloriatur.

Sir Norman Lockyer, K.C.B., F.R.S., Director of the Solar Physics Observatory, South Kensington.

Inter astronomiae et scientiae physicae fines patet provincia, ubi, instrumentis subtilissimis adhibitis, etiam solis ipsius radii retexuntur, et, linearum varietate quadam minutissima observata, corpora prima, e quibus sol ipse est compositus, inter sese distinguuntur. Adest vir in regione tam pulchra exploranda inter principes numeratus, qui, ne his quidem finibus contentus, non solis tantum defectus identidem observavit, sed etiam astronomiae provinciam amplissimam sibi vindicavit. Idem, per annos prope quinque et triginta Actis quibusdam praeclaris luculenter editis, anni cuiusque septimo quoque die rerum naturae totius varietatem orbi terrarum patefecit.

Major P. A. MacMahon, F.R.S., formerly Professor of Physics at the Ordnance College, Woolwich.

Adest deinceps militis insignis filius, miles mathematicis praesertim in studiis spectandus, qui praeter alios laudis titulos etiam scientiarum societatis Britannicae inter ministros praecipuos numeratur. Studiorum suorum in caelo puro, in regione illa sublimi a Cayleio nostro feliciter peragrata, diu versatus, studiis illis caelestibus sermonis Latini Musam pedestrem, longe infra in terris relictam, nihil aliud quam numerorum theoriam quandam e longinquo contemplari patitur. Cetera omnia scientiae tam sublimis mysteria, peritis patefacta, a nobis certe palam divulgari non concessum. Illud autem unum dixerim. Si, Syracusis captis, Archimedem, intentum formis, quas in pulvere illo erudito descripserat, Marcelli in exercitu miles talis aspexisset, caeli spectatorem illum unicum, tormentorum bellicorum machinatorem illum mirabilem, sine dubio nunquam interfecisset, sed velut socium et fratrem statim esset amplexus.

Sir William Ramsay, K.C.B., F.R.S., Professor of Chemistry at University College, London.

Virum inter Caledones suos atque inter Germanos educatum, titulo nostro Academico fortasse eo digniorem putabitis, quod iam in orbe terrarum toto Academiis fere viginti honoris causa est adscriptus. Per annos septemdecim inter Londinienses scientiam chemicam praeclare professus, aëris praesertim elementa exploravit, et (cum alumno nostro insigni, Rayleio, consociatus) elementum illud *Argon* nuncupatum repperisse confitetur. Etiam propterea laudandus est quod in metallis *Helium* invenit; quod in aëre ipso *Neon*, quod *Krypton*, quod *Xenon*, tot elementa ex ipsa rerum naturae origine latentia detexit, detecta nominibus pulchris, nominibus Graecis, ornavit. Nonnullis certe e nobis non ingratum, etiam in elementis novis nominandis linguae Graecae antiquae utilitatem comprobatam contemplari; iuvat etiam ipsius nomen gentile et olim et nuper propter linguarum peritiam inter Caledones celebratum, in rerum et nominum inventore tanto, etiam rerum naturae scientia illustratum admirari.

Arthur Schuster, F.R.S., Professor of Physics in the Victoria University of Manchester.

Virum libenter rursus agnoscimus, qui primum Moeni sui in ripa, deinde inter Mancunienses, denique in urbe Palatina educatus, inter nosmet ipsos et Maxwellii et Rayleii nostri inter adiutores praecipuos olim numerabatur. Postea solis defectioni in India trans Gangen observandae quondam praepositus, a societate regia ob lucis arcana feliciter explorata numismate aureo est donatus. Laetamur virum, qui fluminis paterni in ripa ad rem argentariam non sine lucro magno sese dedere potuisset, scientiae lucem lucro praetulisse et lucem ipsam explorandam elegisse. Virum talem dum coronat, Academia Virtutem ipsam aemulatur,

"diadema tutum
deferens uni propriamque laurum
quisquis ingentes oculo irretorto
spectat acervos."

Sir William Thiselton-Dyer, K.C.M.G., F.R.S., Director of the Royal Botanical Gardens, Kew.

Laurea nostra iuvat hodie decorare virum Florae in studiis insignem, cuius socerum in eisdem studiis illustrem abhinc annos duodequadraginta Academia libenter ornavit. Isidis propter undas educatus, scientiam suam eximiam et in Anglia et in Hibernia professus, Tamesis in ripa, Florae in hortis pulcherrimis, iam per annos prope triginta vitae suae tabernaculum collocavit. Nomen autem eius non modo regionis Tamesinae sed etiam Africae Australis, Africae denique interioris, cum floribus consociatur. Satis amplus igitur laudandi campus patet, campus floribus consitus, omnique pulchritudinis varietate distinctus; sed Flora vocat, sed horti nostri vos invitant, sed oratorem vestrum, Maronis non immemorem, hortos canere volentem, temporis spatium excludit.

"Extremo ni iam sub fine laborum
vela traham et terris festinem advertere proram,
forsitan et pingues hortos quae cura colendi
ornaret canerem, biferique rosaria Paesti,...
verum haec ipse equidem, spatiis exclusus iniquis,
praetereo, atque aliis post me memoranda relinquo."

Dr. J. Lorrain Smith, Musgrave professor of pathology at Queen's College, Belfast, has been appointed professor of pathology and pathological anatomy in the University of Manchester.

Dr. Jules Tannery, subdirector of the Paris École normale supérieure, has been appointed professor of differential and integral calculus, and Dr. Houssay professor of zoology in the faculty of science. These two appointments are consequent upon the inauguration of the new régime at the normal school, which has now been attached to the Sorbonne.

In September, 1902, the Board of Education referred to the consultative committee the question of drafting regulations for the establishment of supplemental registers for teachers of special subjects. Acting upon the report of a subcommittee appointed to consider the subject, the Board of Education has announced that the establishment of supplemental registers will be postponed until the teaching

of the subjects proposed for the supplemental registers has been further organised in connection with general education.

THE Duke of Devonshire, on August 20, handed over from the trustees of the Keighley Mechanics' Institute to the Corporation of the town the title deeds of premises valued at more than 50,000*l.*, which the municipality is taking over. During the course of his speech on that occasion, the Duke of Devonshire referred to the work with which he has been associated as president of the National Association for the Promotion of Technical and Secondary Education. The association has pointed out that the industrial and commercial supremacy of our country, upon which its power and greatness mainly, if not entirely, depend—a supremacy which once was unquestioned and undisputed—is not unassailable and is not unassailed. Our former supremacy rested mainly, if not entirely, upon the possession of great natural resources, and upon the energy and industry of our people. These are not now the only, if they are the chief, elements in industrial success. The discoveries of science and the application of science to industries have revolutionised the conditions of industry. Other nations, among whom Germany and the United States have been foremost, but all other Continental nations—France, Italy, Switzerland, and others—have appeared to realise this fact sooner than we have done, and to make greater efforts, and more organised efforts, than we have done to give to all classes engaged in these industries the scientific instruction which is in the present day the necessary condition of success. There are signs that these efforts on their part, and on the part of other countries, and this comparative negligence on our part are already having effect, and it is incontrovertible that it must sooner or later have a vast effect prejudicial to our own commercial and industrial supremacy. It is now recognised that scientific instruction for the whole of our people is a necessary element to our industrial success. Cultivated brains are as essential to industrial efficiency as even the strongest arms or the most willing hearts. The duty of imparting this instruction to those who need it is one that can no longer be safely left to the efforts of the benevolent or the philanthropic, but is the duty of the State as much as that of national defence, the defence of our Imperial possessions, or the defence of our own shores.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16.—"The Lethal Concentration of Acids and Bases in respect of *Paramoecium aurelia*." By J. O. Wakelin **Barratt**.

The author finds that the strong mineral acids, hydrochloric, nitric, and sulphuric, in 0·0001 N concentration kill Paramœcia in ten to fifty minutes. Organic acids, in the same concentration, kill sometimes with greater rapidity (formic, lactic, and oxalic acids), sometimes with less rapidity (citric and acetic acids). Exceedingly weak acids (carbonic, carbolic, boric, hydrocyanic) require a much greater concentration in order to kill Paramœcia in the above period of time.

The hydrates of potassium, sodium, lithium, calcium, strontium, and barium in 0·002 N concentration are fatal in five to sixty minutes. Ammonium hydrate is more lethal, and far more so is the extremely weak base anilin. The lethal character of the alkalis exhibits an order corresponding to their periodic grouping.

The experiments made indicate that the action of acids and alkalis upon the living protoplasm of Paramœcia is of the nature of a chemical reaction, and is not purely hydrolytic in character.

PARIS.

Academy of Sciences, August 16.—M. Mascart in the chair.—The second approximation to the equation for the flow of sheets of underground water under slight pressures: J. **Boussinesq**.—New researches on the liquefaction of helium: Sir James **Dewar**. A side tube containing charcoal is added to a vacuum tube, and the tube filled with helium. When the charcoal is cooled down by means of liquid hydrogen to 15° C. absolute temperature, the vacuum produced is so good that a coil giving a 16-inch spark in air is required to produce a slight phosphorescent discharge in the middle of the tube. It follows that at this low temperature the charcoal is a good absorbent of helium. These experiments are regarded as confirming the conclusion that the boiling point of helium will not be found to be below 5° C. absolute.—On a crystalline combination of the acetate and thiosulphate of lead, $2PbS_2O_3,(CH_3-CO_2)_2Pb$: P. **Lemoult**. This compound is precipitated from a solution of lead acetate to which some sodium thiosulphate has been added, and the precipitate of lead thiosulphate re-dissolved by the addition of acetic acid. The above formula was established by analysis.—The alloys of zinc and magnesium: O. **Boudouard**. A series of alloys was prepared containing from 5 per cent. to 90 per cent. of magnesium, the melting points of which were determined. The melting point curve showed a maximum and two minima. The maximum corresponded to a definite combination, Zn_2Mg, and the microscopic study of a polished section proved the existence of a second definite compound, $ZnMg_4$. Both these alloys were isolated.—The properties and constitution of chrome steels: Léon **Guillet**. Two series of chrome steels were studied, both by micrography and by mechanical tests. One series contained very little carbon, the other 0·85 per cent. The steels studied were found to fall into four classes, and the limitations to their practical use are given.—On the evolution of structure in metals: G. **Cartaud**. A micrographic study of the crystallisation of lead.—The first stages in the development of *Sacculina carcini*: Paul **Abric**.—On the comparative values of the tissues of the tail from the point of view of regeneration in the larvæ of Alytes, and on the possible absence of this regeneration: P. **Wintrebert**.—The geology of Chabrières (Hautes-Alpes): E. A. **Martel**.

CONTENTS.

THURSDAY, SEPTEMBER 1, 1904.

AMERICAN AND BRITISH YACHTING.

American Yachting. By W. P. Stephens. Pp. ix + 380. (London: Macmillan and Co., Ltd.) Price 8*s.* 6*d.* net.

THIS excellent book not merely contains a well written history of American yachting, but puts on record the principal points in the development of yacht designing, both in the United States and in this country, during the fifty years since the famous *America* came to this country (in 1851) and astonished English yachtsmen by her remarkable performances. The contests between English and American yacht designers have been continuous and keen, including struggles for the America Cup as well as matches of equal or possibly greater interest between yachts of many classes. Some of these have received little attention, although the results have had considerable influence on later construction. The author is a keen sportsman, fully informed upon all branches of his subject, and capable—as many other yachtsmen are in these days—of discussing the problems of yacht design on a scientific basis. Americans have inherited from this country the love of yachting as a sport, and have given repeated proofs that they are formidable rivals in the design and management of yachts. They have gradually reached an appreciation of what Mr. Stephens describes as "the importance of Yachting to a maritime nation." He says:—

"It is a stimulus to the advancement of Naval Architecture, such as is necessary in maintaining the Naval and Merchant Fleets at the highest standard; it is a training school for seamen both amateur and professional; and its mimic battles are constant reminders of the necessity for perpetual progress in all details of Naval development."

As to its influence on individual yachtsmen, Mr. Stephens considers that yachting

"can fairly claim a place amongst the arts and sciences as a purely intellectual pursuit. The Science of Yacht designing, a branch of Yachting which many amateurs follow as a recreation, offers an unlimited field for study and research. The man who can design his own Yacht, large or small, construct her, or at least plan and supervise the construction, and finally can guide her to the head of the fleet with his hand on the tiller, his active brain anticipating each move of clever opponents, may well lay claim to one of the highest achievements within the reach of any sportsman."

Concurrently with the abandonment of "rule of thumb" methods in yacht design, there has been an important change in regard to the publication of information respecting the forms and equipment of yachts. Formerly, secrecy was the rule. Yacht owners took elaborate precautions to prevent the publication of details. Very often this secrecy was associated with an ignorance of principles, resulting in false estimates of the relative value and importance of causes influencing success. The late Mr. Dixon Kemp did much to break down this practice; his books on yachting remain valuable to this day. Mr. Stephens does not enter into technicalities so fully as Mr. Dixon Kemp did, but he writes with intelligence and a grasp of principles, and his summary of events is accompanied by an analysis of distinctive features in successive designs which can be read with interest even by naval architects. He traces the influence of local conditions, and of rules of measurement for competitive sailing, upon American and British yachts. He indicates clearly how these widely differing types have, in process of time and as the result of continuous competition, gradually approximated, and led to the production of vessels on both sides of the Atlantic closely resembling one another in their main features. He gives illustrations of the general principle that as soon as a rule for time allowance is established, yacht designers begin to exercise their ingenuity so as to produce vessels which shall get the greatest possible advantage in time allowance under the particular rule in force, and he shows how, in some cases, very unsatisfactory types have been brought into existence simply for racing purposes. The story of the contests for the America Cup is told with fairness and good feeling. Like most practical yachtsmen, he does not consider that yachting has benefited on the whole thereby. He is too good a yachtsman to favour the production of mere "racing machines," and his opinion of the latest example of American skill (the *Reliance*) is noteworthy, being summed up in the words that while she "represented a new and extreme step in the development of the racing machine, her whole form is confessedly bad for all purposes but cup-racing." In his judgment the tendency of international racing has been to minimise the importance of model and construction, and to increase the influence of the designer, owner, and skipper. His remarks on the "challengers" in recent years run counter to the popular view. He directs attention to the fact that recent challenges have not come from yachtsmen who sail their own yachts, but from men of ample means with little or no yachting experience, who see, in the publicity attending a cup match, a means of advertising themselves.

Incidentally, Mr. Stephens brings into relief the fact that, in the United States, the design of the most successful yachts in recent years has been the work of men of considerable culture and scientific knowledge, like Burgess and the younger Herreshoff. Further, he makes perfectly clear the thoroughness of the study devoted to every problem affecting ultimate success. Not merely has close attention been given to form, stability, and sail equipment, but no expense is spared in the United States to obtain the best possible materials—thus associating strength with lightness; in modifying structural arrangements for the same purpose, or in arranging every item affecting efficiency and rapid working of sails. He frankly acknowledges that in all these matters (which greatly influence the result of yacht racing) his countrymen have obtained substantial advantages over ourselves, and equally he shows his appreciation of the favourable conditions under which they can proceed in drilling their crews and "tuning up" the vessels (to use an American expression) before the cup races take place. To one fact, however, he hardly attaches adequate importance.

namely, that as British yachts have to cross the Atlantic in order to take part in the cup races, they can never be built with that extreme lightness of hull which is possible in vessels constructed on the American coast. This undoubtedly counts for much.

Mr. Stephens is an advocate of yachting as a sport, not in the sense of the races for the America or Seawanhaka Cups. He believes in the Corinthian style of yachting—owners working their own vessels. It is obvious that if he could have his way mere racing machines would disappear. Some incidents which he describes as to the performances of American yachts, and the special risks run in consequence of the production of racing machines, are very striking. Only one can be mentioned, that of the *Mohawk*, a centre-board schooner 140 feet long and more than 30 feet broad, with a depth of hold of less than $9\frac{1}{2}$ feet. This vessel drew only 6 feet when her centre-board was housed. Her sail area was enormous, and she had great initial stability; but in 1876, when at anchor off Staten Island, with all sails set and sheets made fast, she was capsized and sank, carrying with her half a dozen persons. On this side we have had equally extreme dimensions, but under our sailing rules, fortunately, there has not been the same inducement to accept serious risks; our vessels have not been lacking in stability in the sense that they were liable to be capsized.

The book may be heartily commended to all interested in yachting, either as a sport deserving continuance or as a branch of ship design.

W. H. White.

A COMPREHENSIVE WORK ON PHYSICS.

Lehrbuch der Physik. By O. D. Chwolson. Translated into German by H. Pflaum. Second volume. Pp. xxii + 1056. (Brunswick: Vieweg und Sohn, 1904.) Price 18 marks.

A SERIOUS problem is presenting itself to lecturers and writers of text-books on physics. Never, perhaps, has there been such rapid accumulation of knowledge, both in respect to phenomena the fundamental facts of which were found out in the early ages of physical discovery and in respect to new phenomena which reveal themselves in succession to the physical investigator. The brilliant experimental discoveries of Faraday in electrodynamics, the equally distinguished theoretical and experimental researches of Fresnel in optics, the researches of Mayer, Helmholtz, Lord Kelvin, Clausius, and Joule in thermodynamics, which are unsurpassed in importance owing to their wide reaching application to almost every branch of physics, all these make the first half of the nineteenth century unique as an age of physical discovery. This period was followed by one of comparative quiet, in which physicists began to acquire a comfortable feeling that the universe was now known; details undoubtedly there were to be made out, but no striking discovery was expected. This attitude of content was roughly disturbed by the discovery of Röntgen rays in 1895, and still more startlingly so by the discovery of various other types of rays and emanations by Becquerel and his followers. Each of these discoveries has given birth in a most prolific way to a vast crowd of minor discoveries demanding a history of their own; and meanwhile the accumulation of fact and theory in older subjects has steadily gone on, and the problem which presents itself is, How is this huge and ever increasing amount of knowledge to be successfully presented to a student? It is becoming unmanageable. No single course of lectures can deal adequately with it. College courses are beginning to spread over two years, and even then merely skim the subject. The text-book under review illustrates the state of things. It is the second volume out of four. It extends to more than a thousand pages, and deals only with sound and with radiant energy. It contains no elaborate development of mathematical theory—in fact, the weak point of the book is that there is not enough mathematics in it. Wherever the mathematics required is other than of simple kind it is omitted; the final formula may be given, but it is often quoted unproven. How is a student to master the vast mass of material which is extended to him here? It seems inevitable that before long some process of selection must be adopted in order that a student's work may be made more easy for him. Of course, if a book is intended as a book of reference chiefly, the more encyclopædic it is the better; but the present volume is intended as a text-book, and not as an encyclopædia. We think that the ideal text-book is one which will present such a selection from ascertained knowledge as will give a student an adequate grasp of the facts, principles, and methods of his subject. The selection need not and should not be skimped, but no attempt should be made to include *all* that is known to be true.

Regarded as a book of reference, this volume is most admirable, and we commend the enterprise which now brings it into a wider circle of readers. German is not popular amongst English students, but Russian is barred altogether. The matter is excellent and is excellently presented. It is thorough, and is brought well up to date in this edition; *e.g.* there is a good account of Siedentopf and Szigmondy's recent work on the vision of (so-called) ultramicroscopic particles. The chapter on interference is specially good. The illustrations throughout are unusually clear, especially those explanatory of the various instruments of observation.

The man who gets this book has only himself to blame if he learns no physics. Our only quarrel is with the size of the dose. Experience has shown us that a student fights shy of this heroic treatment, and turns for help to the text-books of the cramming institutions. Less formidable treatment might induce him to put the latter away with advantage.

OUR BOOKSHELF.

Wilhelm Ostwald. By P. Walden. Pp. vii + 120. (Leipzig: Wilhelm Engelmann, 1904.) Price 4*s.* net.

Prof. Ostwald has only just attained his fiftieth year, and in appearance he is full of life and vigour. He has done and is doing a great work in science; he is a man one may delight to honour, both for his intellect and for his heart. It may be merely the prejudice of the reticent Englishman, but I must confess to a feeling that these biographies of eminent men in the prime of

life must be very uncomfortable to their subjects, and a doubtful kindness. If they are to become common, mediocrity will find a new consolation.

It is impossible, however, not to admire and, knowing Ostwald, not to share the warmth of feeling which has prompted the publication of this book. It is written on the occasion of the twenty-fifth anniversary of Ostwald's graduation, and in the 120 pages Prof. Walden gives a very readable account of his subject from the age when the hero was "unser Wilhelm" up to the present time. From it we learn that the life of Ostwald has been free from any very dramatic incidents, and that, like so many eminent men, he was an ordinary boy and a not strikingly exceptional student. When once inspired by the teaching of Lemberg, he really breasted the sea of science and struck out on the course which he has followed with such success. His early career as a teacher was fraught with scanty means and imperfect appliances, but resolution, single-minded devotion and splendid ability overcame all obstacles, and have been rewarded, as we know, with every kind of success to which a true man of science may properly aspire. The book will be read with interest not only by Ostwald's friends and pupils, but by all who are interested in the foundation of the modern school of physical chemists. A. S.

The Lepidoptera of the British Islands. A Descriptive Account of the Families, Genera, and Species Indigenous to Great Britain and Ireland, their Preparatory States, Habits, and Localities. By Charles E. Barrett, F.E.S. Vol. ix., Heterocera, Geometrina—Pyralidina. Pp. 454. (London: Lovell Reeve and Co., Ltd., 1904.) Price 12s. net.

THE ninth volume of Mr. Barrett's great work marks substantial progress, and practically completes the Macrolepidoptera. About 180 species are described. The Geometrina include the families Larentidæ (the conclusion here given chiefly consisting of the great genus Eupithecia, of which forty-eight British species are admitted, one doubtful, but also including Eubolia and its allies, formerly placed in a distinct family), and Œnochromidæ, with only two British genera, Tanagra and Aplasta. The Pyralidina include the families Pyraustidæ, Pyralidæ, Hydrocampidæ, Endotrichidæ, Scopariidæ, Pterophoridæ, Orneodidæ, and Phycitidæ. The last family is not quite completed in vol. ix., so there now remain but the Galleriidæ, Crambidæ, Tortricina, and Tineina to be dealt with. As it is possible that these may not require to be treated in such great detail as the Macrolepidoptera, perhaps four or five more volumes may be sufficient to complete the book, which will remain as a permanent record of the work accomplished by British lepidopterists during the latter half of the last century and the opening years of the present. Among the more interesting features of vol. ix. may be noted the carefully-drawn-up table of the large and difficult genus Eupithecia, which ought much to facilitate the determination of species; and the exact records of the occurrence of the rarer species of Pyralidæ, many of which are met with, at least in Britain, only singly and sporadically at long intervals and in widely separated localities. Many interesting species, some of wide distribution abroad, have thus been added to our British lists of late years.

It will be seen that to a considerable extent Mr. Barrett still follows an arrangement similar to that of Stainton's "Manual"; it is, however, a great improvement to associate the Pterophoridæ with the Pyralidæ, as is now generally done. The Orneodidæ are a more aberrant family, and we are not sure that their real affinities have yet been finally determined.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Flowering of the Bamboo.

I HAVE read Mr. Tingle's letter in NATURE for August 11, as well as Prof. Farmer's comments on it, and hope you will permit me to add my remarks to the discussion of the subject.

Mr. Tingle ought to have specified which of the Chinese bamboos it is that has now flowered. According to the list given by Dr. Rendle in the recently published part of the *Journal* of the Linnean Society, vol. xxxvi., there are about forty-two species of bamboo, large and small, in China, and it would be interesting to know which of them it is. Let us hope that Mr. Tingle is sending good specimens to the Kew and British Museum herbaria. Until the species referred to has been ascertained, discussion is rather difficult, except from a general point of view.

My own experience of bamboos is confined to India, where there are more than 120 species, large and small, but I have never heard that their flowering, even when it takes place gregariously, has caused alarm among the natives. The gregarious flowering of the common species such as *Dendrocalamus strictus* or *Bambusa arundinacea* often takes place in an exceptionally dry season, when there may also be partial failure of the crops, and on such occasions advantage is sometimes taken of the general seeding to collect and use the seeds for food. Signs of approaching flowering may, perhaps, occasionally be received with misgiving as foreshadowing a dry season and bad crops, but I have never heard of their being regarded with anything approaching to superstitious terror.

So far as we know at present, some of the Indian-Burmese species only flower gregariously at long intervals, but even then there is some doubt whether the flowering is local only or widespread. The well known Kyathaungwa (*Bambusa polymorpha*), a large species with culms up to 80 feet in height and 6 inches in diameter, and notable as a common associate of the teak tree, was collected in flower by Dr. M'Clelland in Pegu in 1854, by Sir D. Brandis in the Salween in 1862, and by Mr. S. Kurz in the Sittang Valley in 1871, and flowers have once been reported since from Bassein; but in more recent years it has not flowered, though its gregarious flowering is being anxiously awaited by forest officers, who hope to use the opportunity for the extension of teak reproduction. There are some species of bamboo which flower regularly every year and do not die off: among them are the little *Arundinaria Wightiana*, so common in the forests around Ootacamund in the Nilgiri Hills; *Bambusa lineata*, a small reedy species of the coast forests of the Malay Archipelago, extending westwards only to Rutland Island in the Andamans, though strangely enough it has not, so far as I am aware, been known to produce seed; and *Ochlandra stridula*, a shrubby species of the low country of Ceylon. The great majority of species, however, have their chief flowerings gregarious, at more or less regular intervals, while every now and again a few clumps may be found in flower sporadically in almost any year. This is especially the case with *Dendrocalamus strictus*, the "male bamboo" so widespread in the deciduous more or less dry forests of India and Burma; with the thorny *Bambusa arundinacea* of the Western Peninsula; with *Dendrocalamus Hamiltonii*, the most common species of northern Bengal and Assam; and with *Bambusa Tulda* in Bengal, the east coast hills, and Burma. Gregarious flowerings may really be often quite local, though widespread enough within their locality.

When, in India, bamboos flower gregariously, they usually produce quantities of good seed, and the old clumps then die off; but in sporadic flowerings my experience is that seed is very little produced, or if produced infertile, while the clumps occasionally may recover, though rarely. Damage to a clump may often produce a partial or sporadic flowering. Information on the subject is being gradually collected in India; the dates of flowering of the different species are, when observed by forest officers,

recorded in their journal, the *Indian Forester*, and the behaviour of the clumps is being carefully watched, especially as the dying off of the clumps of a species over large areas may mean a serious dearth for several years of the most useful material for the construction of native houses and of many articles of common domestic use. I would therefore invite the attention of those interested in the subject to the pages of the journal mentioned, and I hope Mr. Tingle and others will collect similar information in China. As regards the flowering of cultivated species in the gardens of this country, some very useful information was given by Mr. Bean, of Kew, in the *Gardeners' Chronicle* for 1903. I am not quite sure that all the flowered clumps of *Arundinaria Falconeri* will die. I have one in my own garden, and I think it is quite likely to live. I recently saw, in a neighbour's garden, a large clump of *A. Simoni* which had flowered and apparently died, but the root-stock is now studded with young green shoots, and they look as if they intended to grow. I think it is because all the culms had been cut away after the flowering.

J. S. GAMBLE.

Highfield, Liss, Hants, August 14.

The Spontaneous Scintillations of Hexagonal Blende.

A SHORT time ago I pointed out in the *Chemical News* (1904, p. 33) that scintillations, similar to those produced by a radium salt, but feebler, can always be observed in hexagonal blende, in the absence of any radium or radium-emanation.

I have recently made experiments in order to determine whether the blende itself is radio-active, and whether such inherent radio-activity is the cause of the spontaneous scintillations.

An electroscope was used with paraffin-wax insulation and a long aluminium leaf. The rate of leak was first determined, and then the effect produced on the rate by placing the blende on the brass plate of the electroscope. Two specimens from a French firm were examined in this way, and showed no effect whatever; they were spread over the plate in the form of powder.

A specimen from an English firm, in the form of a screen 4 cm. square, showed a marked effect, but a piece of writing-paper of the same size produced the same effect; consequently, no radio-activity can be attributed to the blende on the screen. All these specimens showed the scintillations distinctly, and I can only adhere to my original opinion that the scintillations are caused by a spontaneous change in the structure of the crystals.

E. P. PERMAN.

University College, Cardiff.

Sooty Rain.

I SHOULD be glad if any of your readers could explain the following phenomenon:—

It occasionally happens that on still days, usually with light northerly winds, a heavy shower of rain will carry down a black greasy deposit which forms a film or scum on this and other lakes in the district. It is a recognised nuisance to owners of pleasure boats, as, from the adhesive nature of the scum, scrubbing with soap and water is necessary to remove it.

This black deposit has been examined for me by a competent biologist, and contains no products of organic life. It has, in fact, the appearance and oily character of ordinary soot. I have seen a small handful (when dry) scraped up here from the shore. Sooty rain is the exception, and not the rule. In May last there were about eight days of sooty rain, with the wind out of the north-east. During the last three months, though the lake has risen more than a foot, there has been only one sooty rainfall, viz. on August 17, when the wind was again in the north.

Yesterday (Sunday, August 21, 4 p.m.) I had an opportunity of observing the formation of the scum, and was surprised to see how quickly it appeared. The day had been still, with heavy clouds at a considerable height coming up slowly from west-south-west, with an occasional light breeze from the north. At 4 o'clock the wind dropped entirely, and a sudden heavy shower of rain fell which lasted about fifteen minutes.

As soon as the rain began, the surface of the lake appeared broken up into faintly defined dull and bright patches, which in two or three minutes became strongly intensified without losing their original shape. The dull patches consisted of the sooty film, which was easily observable by dipping in a sheet of white paper, to which the soot adhered.

The position of the Lake District in regard to manufacturing centres renders the occurrence of sooty rain under the conditions described rather remarkable. It would be interesting, too, to know why the sooty film should not cover the surface of the water uniformly, instead of in patches. These patches, by the way, are known locally as "tarns," and are supposed to forecast a spell of bad weather.

Coniston, Lancs., August 22. J. B. COHEN.

Adaptive Colours of Eyes.

SOME time ago Prof. Wallace, of the School of Mines, Kimberley, suggested to me the possible explanation of the difference in colour of the light reflected from the iris of the eyes of different people—that it was in accordance with the natural law of protection against external influences. He pointed out that people hailing from regions where blue light is predominant—Swedes, Norwegians, and sailors, for instance—have blue eyes, whilst near the equator, or in sandy climes such as South Africa, where intense yellow light is experienced, the eyes take a rich dark yellow hue, as those of the Kaffirs and Malays, Italians and Spaniards. The Scotch have blue, the English grey, and the French dark eyes, generally speaking.

I wish to know whether this novel explanation will bear criticism under the searching light some of your readers may be able to throw on the matter.

A. VINCENT NAPIER.

Beaconsfield, Kimberley, South Africa, July 21.

An Optical Phenomenon.

SOME sixteen years ago I observed phenomena which appear to be related to those mentioned by Mr. Hillig on p. 366 of NATURE, and by Mr. Walker on p. 396. A disc, in which was a ring of holes, was rotated between the eye and the sky. I saw coloured patches and rings, changing with the velocity of rotation. The appearances vanished as the rate of rotation increased. The colours were pale green and purple. The purple flowed about as if fluid, and the green appeared as islands mottling its surface. It occurred to me that there might be some connection with the visual purple of the retina.

It would be of interest to repeat the experiments, using the different spectral colours, and varying the rates of rotation.

Intermittent stimulation of the retina may give rise to very curious and interesting results.

In the concluding chapter of Mr. Bidwell's "Curiosities of Light and Sight" will be found an account of some remarkable effects produced by intermittent illumination.

Leeds, August 27. C. T. WHITMELL.

The Constitution of Matter.

HAVING followed the almost brilliant discussions concerning the constitution of matter which took place at the recent Cambridge British Association meetings, I was not a little surprised to come across the following remarks made by Ralph Waldo Emerson in 1867. He said: "The chemists already find the infinite variety of things contained in sixty-six elements; and physicists promise that this number shall be reduced to twenty, ten, five. Faraday declares his belief that all things will, in the end, be reduced to one element with two polarities."

It would be interesting to know exactly the phraseology in which Faraday expressed this belief.

R. W. Emerson merely uses the statement to aid religious views. And yet in several of his writings he has selected almost prophetic utterances concerning science.

C. ALFRED SMITH.

King's College, London, August 29.

THE INFANTS' MILK DEPÔT.

THE annual toll of infant lives in all countries is a heavy one. At the present day in most civilised countries the problems of infantile mortality have come into prominence from many causes, chiefly the declining birth-rate, and although in England the general death-rate has fallen from 22·6 per 1000 in the five-yearly period 1851–5 to 17·6 in 1896–1900, the infant mortality, that is, the death-rate of infants under one year per 1000 births, has remained stationary (156) in those two periods. In the great industrial centres the infant mortality ranges from 168 to 182, and if it could be reduced to 104, which is the average of the semi-rural counties, there would be a saving of 40,000 lives annually. Dietetic diseases are mainly responsible for this terrible loss of life, and from one-third to one-half of the total infant mortality is due to diarrhœa, which is especially active in hot summers.

These conditions are chiefly attributable to improper feeding, and to the use of milk which bacteriologically is grossly polluted. These sources of danger to the infant population would, of course, be inoperative were breast-feeding the rule, but breast-feeding seems to be difficult to secure, partly from the selfishness of mothers, and partly from an ignorance which assumes that hand-feeding can take its place. It is naturally among the poor that improper feeding chiefly obtains. The infant from its earliest days, in lieu of its natural nourishment, has tit-bits from the parents' table and various concoctions of cow's milk, condensed milk, and infants' foods. With regard to the latter, it has been remarked that if a mixture of chicory with coffee is sold as pure coffee the trader is liable to prosecution, but that anyone may make up any sort of mixture and call it a perfect infants' food, and the law leaves him alone!

There is obviously a great field for specialised measures of prevention against the dietetic diseases of infants, and organisations have therefore been established for the supply of sterilised milk for the babies of the poor, and incidentally to teach the mothers how their children should be reared, and to encourage breast-feeding whenever practicable.

Many of these infants' milk depôts are now in active work, both on the Continent, and in England at St. Helens, Liverpool, Battersea, and other districts, and their administration is summarised by Dr. McCleary, the medical officer of health for Battersea, in a useful paper.[1] In Battersea this is as follows:—The milk for use at the depôt is carefully controlled, and special conditions have to be accepted by the contractor. The amount of milk requisite for a single meal, and suited to the age of the infant, is contained in a screw-stoppered bottle; for the youngest infants it is modified by the addition of water, cream, and sugar according to recognised principles. The bottles are then placed in the sterilising chamber (see illustration), steam is injected, and the temperature raised to 212° F., which is maintained for about ten minutes. They are then taken out of the steriliser and rapidly cooled in a cooling tank. The bottles are supplied in wire baskets, each basket holding from six to nine bottles, and containing a twenty-four hours' supply. The next day the basket of empty bottles is returned, and a fresh supply obtained. When a child is entered at the depôt the mother is instructed by the manageress as to the proper method of using the milk, and she receives a printed leaflet of instructions. The cost varies according to age, from 2s. to 2s. 9d. per week.

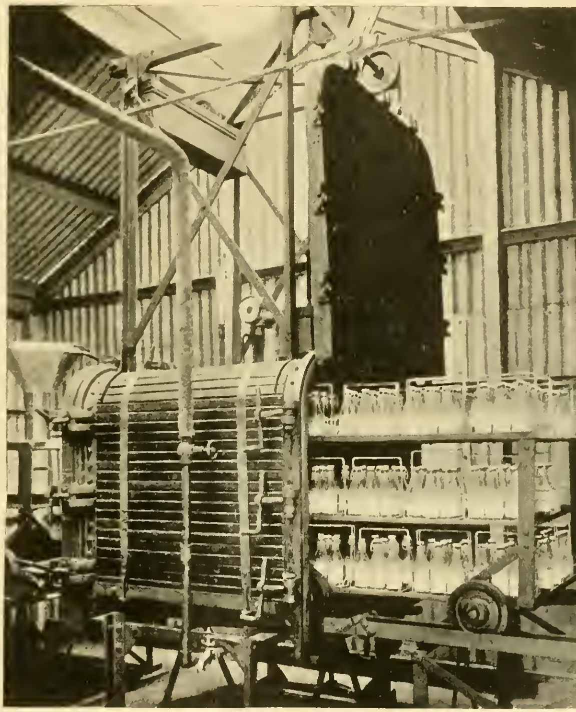

FIG. 1. Infants Milk Depôt, Battersea. Interior o. sterilising room, showing steriliser with loaded trolley. (From the *Journal of Hygiene*.)

The method of infant feeding is a very simple matter so far as the mother is concerned. When feeding time arrives, all she has to do is to place a bottle, unopened, in a basin of warm water until it reaches body temperature, to open the bottle, put on a rubber teat supplied at the depôt, and feed the baby from the sterilised bottle direct. There is no need for a "feeding bottle," which alone is a great advantage.

The homes of the children fed on the milk are visited by the lady sanitary inspectors, who endeavour

[1] "The Infants' Milk Depôt: its History and Function" (*Journal of Hygiene*, iv., No. 3, July, 1904, p. 329).

to secure that the instructions are properly carried out. If the child does not appear to be progressing favourably, the mothers are strongly advised to seek medical advice. Mothers are urged to bring the children once a week to be weighed.

As to the results of the working of these institutions, it is not yet possible to speak, and there are many fallacies that have to be guarded against in considering the statistics. Dr. Drew Harris calculated that for the three years 1899–1901 at St. Helens the death-rate among children attending the depôt averaged 104, while in the whole borough it was 173. At the recent Congress of the Royal Institute of Public Health, Mr. Councillor Shelmerdine stated his conclusions for Liverpool as follows:—"that of the 4453 infants coming very promiscuously to the depôts at varied ages and in conditions of health below the average the mortality was 78 per 1000 as against 159 per 1000 for the whole city. But it must be remembered that in that 159 per 1000 for the whole city and 88 to 118 for the best districts, and 212 to 215 for the worst districts, were included also breast-fed infants; clearly if breast-fed infants were excluded and artificially-fed infants only taken into account the rate of mortality amongst them would be enormously higher, and would show even more forcibly the advantages of the sterilised food which, of course, is an artificial food, over other methods of artificial feeding."

R. T. HEWLETT.

EXHIBITION OF ANCIENT EGYPTIAN SCULPTURE AT THE BRITISH MUSEUM.

VISITORS to the British Museum galleries of antiquities will notice that a considerable alteration has lately been effected in the arrangement of the Egyptian sculptures of the early period, and that many antiquities which have not hitherto appeared in the galleries are now on exhibition for the first time. Most of the newly exhibited monuments date to the most ancient period of the Egyptian monarchy, of which the British Museum has until lately not possessed many specimens; some are monuments of prime importance historically as well as artistically, and nearly all owe their appearance in London to the present Keeper of the Department of Egyptian and Assyrian Antiquities, Dr. E. A. Wallis Budge, who has personally superintended their removal from Egypt and their exhibition in the galleries of his department. The British Museum is now in a fair way of making up its deficiency in larger monuments of the older period—the "ancient" and "middle" Empires—and few museums out of Egypt can show so fine a collection of funeral stelæ of the fourth and fifth dynasties.

These are chiefly exhibited in the vestibule at the end of the Egyptian saloon. This vestibule is now practically given up to monuments of the "ancient Empire." The most important of them takes the central position, and is one of the finest Egyptian monuments in the museum. This is the great stele which faced the doorway in the *mastaba* tomb of Ptahshepses, at Sakkara. Ptahshepses was one of the chief men of the court of Shepseskaf, the last king of the fourth dynasty. He was brought up by Menkaura, Herodotus's Mykerinos, the builder of the third pyramid of Giza, among the royal children, and was given the king's daughter Khamaat to wife. Offices of trust and honour were piled upon him, and to judge by the explanatory label below his monument, upon which all his titles are set forth, he ought to be the patron saint of pluralists. The colour of this monument is well preserved, and used as we may be to the idea of paint laid on under the eighteenth dynasty (B.C. 1500) being still preserved in all its pristine brilliancy of colour, it is another thing to find delicate colouring applied in the days of the pyramid builders—whose days were separated from those of the eighteenth dynasty by nearly as much time as separates the eighteenth dynasty from us—still bright and still delicate. It is to be hoped that London fogs will not sully it.

Other monuments of the same period and type are arranged round this fine centre-piece, and all are interesting. Those who are interested in the work of men's hands in the dawn age of civilisation should not miss this important exhibition of Egyptian antiquities of the Ancient Empire.

THE BRITISH ASSOCIATION AT CAMBRIDGE.

AT the final meeting of the general committee last week, a report from the committee of recommendations was received and accepted with some slight alterations. One of the recommendations was made with the object of securing the continuity of sectional committees from one meeting to the next. Secondly, it was proposed that each sectional committee should have power to appoint during the annual meeting not more than three vice-presidents. Another recommendation had reference to the constitution of the council and the appointment of assistant secretary.

The following is a synopsis of grants of money appropriated to scientific purposes by the general committee:—

Mathematics and Physics.	
*Rayleigh, Lord—Electrical Standards	£40
*Judd, Prof. J. W.—Seismological Observations ...	40
*Shaw, Dr. W. N.—Investigations of the Upper Atmosphere (Kites)	40
*Preece, Sir W. H.—Magnetic Observations	50
Chemistry.	
Kipping, Prof. F. S.—Aromatic Nitramines	25
Armstrong, Prof. H. E.—Dynamic Isomerism ...	20
*Roscoe, Sir A. E.—Wave-length Tables of Spectra ...	5
*Divers, Prof. E.—Study of Hydro-Aromatic Substances	25
Geology.	
*Watts, Prof. W. W.—Movements of Underground Waters	Balance in hand
*Marr, Dr. J. E.—Life Zones in British Carboniferous Rocks	Balance in hand
*Lamplugh, G. H.—Fossiliferous Drift Deposits	Balance in hand
*Marr, Dr. J. E.—Erratic Blocks...	10 and unexpended balance
*Herdman, Prof. W. A.—Fauna and Flora of British Trias	10
Zoology.	
*Woodward, Dr. H.—Index Animalium...	75
*Hickson, Prof. S. J.—Table at Zoological Station at Naples	100
*Weldon, Prof.—Development of Frog	10 and unexpended balance
*Hickson, Prof. S. J.—Higher Crustacea	15 and unexpended balance
Geography.	
Murray, Sir J.—Investigations in the Indian Ocean...	150
Economic Science and Statistics.	
*Cannan, Dr. E.—Trade Statistics	20

* Reappointed.

Anthropology.	
*Read, C. H.—Age of Stone Circles	£40
*Cunningham, Prof. D. J.—Anthropometric Investigations	10
*Evans, A. J.—Excavations on Roman Sites in Britain	10
Evans, Sir J.—Excavations in Crete	75 and unexpended balance
Macalister, Prof. A.—Anthropometry of Native Egyptian Troops...	10
*Munro, Dr. R.—Glastonbury Lake Village ...	Balance in hand
*Tylor, Prof. E. B.—Anthropological Teaching	Balance in hand
Physiology.	
*Gotch, Prof.—Metabolism of Individual Tissues ...	30 and unexpended balance
*Halliburton, Prof. W. D.—State of Solution of Proteids	20
Schäfer, Prof.—The Ductless Glands	40
Botany.	
Scott, Dr. D. H.—Structure of Fossil Plants... ...	50
*Ward, Prof. H. Marshall—Physiology of Heredity ...	35
Miall, Prof.—Botanical Photographs	5
Educational Science.	
Magnus, Sir P.—Studies suitable for Elementary Schools	20
Corresponding Societies.	
*Whitaker, W.—Corresponding Societies Committee...	20
	£1000

The concluding meeting of the Association was held in the Senate House on August 24, the President being in the chair.

Sir J. Evans moved a vote of thanks to the Vice-Chancellor of the university and to the Mayor and Corporation of Cambridge for their reception of the Association, and for the use of the municipal and university buildings; also to the chairman of the County Council of Cambridge and the Isle of Ely for their assistance on behalf of the Association.

The Vice-Chancellor (Dr. Chase) replied for the university, the Mayor of Cambridge on behalf of the corporation, and Mr. E. S. Fordham on behalf of the county council.

Votes of thanks to the local committee and to the gentlemen and public bodies who had extended their hospitality to the Association were also carried.

At the suggestion of Mr. Balfour, Prof. George Darwin, the president of the meeting to be held next year in South Africa, made a few remarks, in the course of which he said that he was deeply sensible of the compliment that had been paid to him in nominating him for the office of president of the British Association, but he felt that he had exceptional difficulties to face. It was not only that for one year he had been nominated to serve as the figure-head of British science, but on this occasion he would have to act as a sort of ambassador for science in the home country to budding science in South Africa. Cambridge was a university of many centuries' standing; and South Africa had aspirations that her universities should in future be as great. But there was a long road to travel before that hope could be fulfilled. One of the objects of the Association's visit to South Africa was to aid her in achieving those aspirations. The visit might do much good in helping local men to foster their institutions for higher education and for the prosecution of science.

Mr. Balfour said that there could not be a more fitting conclusion to Prof. Darwin's speech than to announce, as he now did, that the meeting was adjourned until August 15, 1905, at Cape Town.

* Reappointed.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY DOUGLAS W. FRESHFIELD, PRESIDENT OF THE SECTION.

On Mountains and Mankind.

A GEOGRAPHER or traveller who has been called upon to preside over the meetings of our Section of the British Association may be excused for feeling some hesitation as to the character he shall give to the Address which custom compels him to deliver. He cannot but be aware that his audience, while it includes not a few experts, probably far better qualified than himself to take the Chair, is composed mainly of those whose concern in Geography can only be a general and occasional one.

To compose a summary of the geographical events of the year would be a simple and obvious expedient, were I not conscious that in this I have been forestalled by the indefatigable President of the Royal Geographical Society. To consider the progress of geography, during, say, the last quarter of a century, might be instructive to "the general." On the other hand, on his special subject your President may possibly be able to add something to the common stock by way of observation or suggestion.

Bearing in mind the, from the point of view of posterity, almost excessive energy with which the nineteenth century carried on the exploration of the globe, narrowing in every direction the field left to our explorations and our imaginations, 1904 may so far be counted as an "annus mirabilis" in the annals of Geography. We have seen the successful return, if not as yet to our own shores, to safe seas, of the most important expedition ever sent South Polewards. In the success obtained by Captain Scott and his comrades, we have welcomed a full justification of the course taken in putting the supreme command and direction of the undertaking in the hands of an officer of His Majesty's Navy. "England expects every man to do his duty," and I will not indulge in hyperbolical praise, which must be distasteful to men who have shown in trying circumstances the daring, the cheerfulness, and the resourcefulness which we are accustomed to associate with the British Navy. We have every reason to expect that the results obtained by the energetic and capable men of science attached to the expedition will be of wide bearing and interest, but to attempt to estimate them to-day would be obviously premature.

The current year has been distinguished by a, perhaps, even more remarkable geographical event. His Majesty's Government, not satisfied with the laurels it has won in the Antarctic, has embarked on a second geographical adventure on a larger scale and at a far greater cost (which, however, will presumably be borne by India). It has sent forth a Gold Medallist of the Royal Geographical Society, Colonel Younghusband, with a numerous escort to reach the forbidden capital of Tibet. The saffron-vested monks on the "golden terraces" of the Pota La have seen the glimmer of British bayonets on the horizon, and the castle-palaces of Lhasa will, we hope, open to the military explorer their mysterious halls, hitherto known to us best by the descriptions of that entertaining traveller, my friend Chandra Das.

But the fruits of these great expeditions are not yet ripe. I must leave them to be plucked by my successors. I do so with regret, for I should have listened with a peculiar interest to an account of the fascinating land, over whose peaks and pastures I lately gazed from the Pisgah heights of the Jonsong La.

To review the progress of Geography during the last twenty-five years, the time that has passed since I first joined the Council of the Royal Geographical Society, is tempting. The retrospect would on the whole be encouraging. The past quarter of a century, if not an era of the most extensive discoveries, has been an era of profitable occupation—I mean profitable in the scientific and not in the commercial sense, though the two are frequently connected—of the ground seized by the great pioneers in Africa, in the backlands of North America, and elsewhere. And when we come to consider the manner in which the results of modern exploration are recorded, what an advance we find! Compare the geographical publications of Great Britain in 1880 and 1904; take the most conspicuous instance, those of the Royal Geographical Society at the

two periods. Consider the way in which our lectures and literature are now illustrated by the aid of photography, new processes, and the lantern. Petermann's *Mitteilungen* was for long the one first-rate geographical magazine in Europe. We have now, as we ought to have had long before, a *Journal* that rivals it.

Take a wider survey. Look at maps, beginning with the Ordnance Survey. Compare the last issues of the one-inch maps, with all the advantages of colour-printing, over their doubtless (except as to roads) accurate, but far less intelligible predecessors. Consider the maps private firms, Messrs. Bartholomew and Messrs. Stanford, have provided us with; note the new editions of "Murray's Guides."

The correction and completion of maps by new explorations is always desirable. But it is even more important that a sound system for the delineation of natural features should be adopted both for Government surveys and general maps. I begin to look forward to a time when glaciers will no longer be represented, as they were on the early Indian and Caucasian surveys, without their heads or tails—that is, without either their névés or their moraine-cloaked lower portions or with rivers rising above them and flowing through them. In time, perhaps, every closet cartographer will recognise that glaciers do not lie along the tops of lofty ridges, but descend into valleys. In these matters I have had many an arduous struggle. It is cruel that a poor man should be set to delineate snow mountains who has never seen one, and when "a week at lovely Lucerne" can be had for 5*l*. 5*s*. it is inexcusable.

In my schooldays there was an exercise of memory known to us by the contemptuous appellation of "Jog," which boys and masters united to depreciate and despise. This sentiment is now confined to a few elderly generals and headmasters. Geography flourishes as a branch of science under the august shadow of the elder Universities. At Oxford we have produced Mr. Mackinder and Dr. Herbertson, Mr. Grundy, Mr. Hogarth, Mr. Beazley. We have started a school of Geography and a school of Geographers. At Cambridge a Board of Geographical Studies has been established. I may quote what Sir C. Markham said three months ago:—

"The staff of the new geographical school at Cambridge will consist, instead of one reader, of several lecturers and teachers, who will cover the various departments of the science. A diploma in geography will be granted as at Oxford. But Cambridge goes a step further than Oxford, by introducing geography into the examination for the B.A. degree. The importance of according geography such a position in the studies of the Universities must be evident to all, and must be specially gratifying to those who, for more than thirty years, have fought hard, amid much discouragement, to have geography recognised as a University subject. It will be interesting to see how the Board of Geographical Studies at Cambridge will draw up the detailed regulations for the degree and the diploma, what steps will be taken to secure a competent staff to cover the whole field of our science, and especially to train young University men for practical work in the field. We have every reason to expect that the results will prove satisfactory.

"The Geographical Association of Teachers, of which Mr. Mackinder and Dr. Herbertson are active members, is doing much to enlighten teachers with regard to the capabilities of the subject, to raise its standard, and to introduce improved methods of teaching. An interesting and useful conference was held last winter at the Chelsea Polytechnic, under its auspices, and in connection with the conference there was an excellent exhibition of appliances used in teaching geography, the usefulness of which was increased by sending it to various provincial centres."

In primary schools many teachers are furnishing excellent instruction, and are instructing themselves in the handbooks provided by our friends Dr. Mill and Mr. Chisholm and others. In the higher branches of education the problems of scientific geography are studied, and teachers are encouraged to develop the geographical aspects of other subjects, such as archæology, history, commerce, colonisation on the one hand, botany and natural history on the other. We have moved forwards and upwards, but do not let us flatter ourselves that we have as yet reached any considerable eminence. Probably many more of our countrymen can read a map in this generation than could in the last. A small percentage, I am glad to notice, are not hopelessly bewildered even by contour lines.

We are learning our geographical alphabet. In time we may, as a nation, be able to read and to understand what we read. We shall recognise that ability to use a map and judge ground is a considerable safeguard against waste of life and disasters in war, and that an acquaintance with the features of the earth's surface and geographical distribution is an invaluable help to a nation in the commercial rivalries and struggles of peace.

When the question of establishing Geography at Oxford was being discussed, Dr. Jowett (who had himself somewhere in the 'fifties suggested the erection of a geographical chair) asked me if I believed Geography could be taught so "as to make men think." We should, I believe, "think imperially" to more purpose if we also took pains "to think geographically." But I will not detain you and use up my time by going in any detail into the progress of Geography. I might find myself only repeating what others have said better. And as to one important branch, perhaps the most important branch, geographical education, on which I addressed this Section at Birmingham some fifteen years ago, I feel myself debarred by the fact that the Association has now a Section specially devoted to Education.

I have determined on the whole, therefore, to run the risk of wearying some of my listeners by inviting your attention to the place in Geography of the natural objects which have had for me through life the greatest and most enduring attraction. I propose to talk about mountains, their place in Nature, and their influence, both spiritual and material, on mankind.

We have all of us seen hills, or what we call hills, from the monstrous protuberances of the Andes and the Himalaya to such puny pimples as lie about the edges of your fens. Next to a waterfall, the first natural object (according to my own experience) to impress itself on a child's mind is a hill, some spot from which he can enlarge his horizon. Hills, and still more mountains, attract the human imagination and curiosity. The child soon asks, "Tell me, how were mountains made?" a question easier to ask than to answer, which occupied the lifetime of the father of mountain science, De Saussure. But there are mountains and mountains. Of all natural objects the most impressive is a vast snowy peak rising as a white island above the waves of green hills—a fragment of the arctic world left behind to commemorate its past predominance—and bearing on its broad shoulders a garland of the Alpine flora that has been destroyed on the lower ground by the rising tide of heat and drought that succeeded the last Glacial epoch. Midsummer snows, whether seen from the slopes of the Jura or the plains of Lombardy, above the waves of the Euxine or through the glades of the tropical forests of Sikkim, stir men's imaginations and rouse their curiosity. Before, however, we turn to consider some of the physical aspects of mountains, I shall venture, speaking as I am here to a literary audience, and in a University town, to dwell for a few minutes on their place in literature—in the mirror that reflects in turn the mind of the passing ages. For Geography is concerned with the interaction between man and Nature in its widest sense. There has been recently a good deal of writing on this subject—I cannot say of discussion, for of late years writers have generally taken the same view. That view is that the love of mountains is an invention of the nineteenth century, and that in previous ages they had been generally looked on either with indifference or positive dislike, rising in some instances to abhorrence. Extreme examples have been repeatedly quoted. We have all heard of the bishop who thought the devil was allowed to put in mountains after the fall of man; of the English scribe in the tenth century who invoked "the bitter blasts of glaciers and the Pennine host of demons" on the violaters of the charters he was employed to draft. The examples on the other side have been comparatively neglected. It seems time they were insisted on.

The view I hold firmly, and which I wish to place before you to-day, is that this popular belief that the love of mountains is a taste, or, as some would say, a mania, of advanced civilisation, is erroneous. On the contrary, I allege it to be a healthy, primitive, and almost universal human instinct. I think I can indicate how and why the opposite belief has been fostered by eminent writers. They have

taken too narrow a time-limit for their investigation. They have compared the nineteenth century not with the preceding ages, but with the eighteenth. They have also taken too narrow a space-limit. They have hardly cast their eyes beyond Western Europe. Within their own limits I agree with them. The eighteenth century was, as we all know, an age of formality. It was the age of Palladian porticoes, of interminable avenues, of formal gardens and formal style in art, in literature, and in dress. Mountains, which are essentially romantic and Gothic, were naturally distasteful to it. The artist says "they will not compose," and they became obnoxious to a generation that adored composition, that thought more of the cleverness of the artist than of the aspects of Nature he used as the material of his work. There is a great deal to be said for the century; it produced some admirable results. It was a contented and material century, little stirred by enthusiasms and aspirations and vague desires. It was a phase in human progress, but in many respects it was rather a reaction than a development from what had gone before. Sentiment and taste have their tides like the sea, or, we may here perhaps more appropriately say, their oscillations like the glaciers. The imagination of primitive man abhors a void, it peoples the regions it finds uninhabitable with aery sprites, with "Pan and father Sylvanus and the sister Nymphs," it worships on high places and reveres them as the abode of Deity. Christianity came and denounced the vague symbolism and personification of Nature in which the pagan had recognised and worshipped the Unseen. It found the objects of its devotion not in the external world but in the highest moral qualities of man. Delphi heard the cry "Great Pan is dead!" But the voice was false. Pan is immortal. Every villager justifies etymology by remaining more or less of a pagan. Other than villagers have done the same. The monk driven out of the world by its wickedness fell in love with the wilderness in which he sought refuge, and soon learnt to give practical proof of his love of scenery by his choice of sites for his religious houses. But the literature of the eighteenth century was not written by monks or countrymen, or by men of world-wide curiosity and adventure like the Italians of the Renaissance or our Elizabethans. It was the product of a practical commonsense epoch which looked on all waste places, heaths like Hindhead, or hills like the Highlands, as blemishes in the scheme of the universe, not having yet recognised their final purpose as golf links or gymnasiums. Intellectual life was concentrated in cities and courts, it despised the country. Books were written by townsmen, dwellers in towns which had not grown into vast cities, and whose denizens therefore had not the longing to escape from their homes into purer air that we have to-day. They abused the Alps frankly. But all they saw of them was the comparatively dull carriage passes, and these they saw at the worst time of year. Hastening to Rome for Easter, they traversed the Maurienne while the ground was still brown with frost and patched untidily with half-melted snowdrifts. It is no wonder that Gray and Richardson, having left spring in the meadows and orchards of Chambéry, grumbled at the wintry aspect of Lanslebourg.

That at the end of the eighteenth century a literary lady of Western Europe preferred a Paris gutter to the Lake of Geneva is an amusing caricature of the spirit of the age that was passing away, but it is no proof that the love of mountains is a new mania, and that all earlier ages and peoples looked on them with indifference or dislike. Wordsworth and Byron and Scott in this country, Rousseau and Goethe, De Saussure and his school abroad broke the ice, but it was the ice of a winter frost, not of a Glacial period.

Consider for a moment the literature of the two peoples who have most influenced European thought—the Jews and the Greeks. I need hardly quote a book that before people quarrelled over education was known to every child—the Bible. I would rather refer you to a delightful poem in rhyming German verse written in the seventeenth century by a Swiss author, Rebman, in which he relates all the great things that happened on mountains in Jewish history: how Solomon enjoyed his Sommerfrische on Lebanon, and Moses and Elias both disappeared on mountain tops; how kings and prophets found their help among the hills; how closely the hills of Palestine are connected with the story of the Gospels.

Consider, again, Greece, where I have just been wandering. Did the Greeks pay no regard to their mountains? They seized eagerly on any striking piece of hill scenery and connected it with a legend or a shrine. They took their highest mountain, broad-backed Olympus, for the home of the gods; their most conspicuous mountain, Parnassus, for the home of poetry. They found in the cliffs of Delphi a dwelling for their greatest oracle and a centre for their patriotism. One who has lately stood on the top of Parnassus and seen the first rays of the sun as it springs from the waves of the Ægean strike its snows, while Attica and Bœotia and Eubœa still lay in deep shadow under his feet, will appreciate the famous lines of Sophocles, which I will not quote, as I am uncertain how you may pronounce Greek in this University. You may remember, too, that Lucian makes Hermes take Charon, when he has a day out from Hell, to the twin-crested summit, and show him the panorama of land and sea, of rivers and famous cities. The Vale of Tempe, the deep gap between Olympus and Ossa, beautiful in its great red cliffs, fountains, and spreading plane-trees, was part of a Roman's classical tour. The superb buttresses in which Taygetus breaks down on the valley of the Eurotas were used by the Spartans for other purposes besides the disposal of criminals and weakly babies. The middle regions—the lawns above the Langada Pass, "virginibus bacchata Lacænis Taygeta"—are frequented to this day as a summer resort by Spartan damsels. The very top, the great rock that from a height of 8000 feet looks down through its woods of oaks and Aleppo pines on the twin bays of the southern sea, is a place of immemorial pilgrimages. It is now occupied by a chapel framed in a tiny court, so choked with snow at the beginning of June that I took the ridge of the chapel roof for a dilapidated stoneman. I have no time to-day to look for evidence in classical literature, to refer to the discriminating epithets applied in it to mountain scenes.

A third race destined apparently to play a great part in the world's history—the Japanese—are ancient mountain lovers. We are all aware that Fusiyama to the Japanese is (as Ararat to the Armenians) a national symbol; that its ascent is constantly made by bands of pilgrims; that it is depicted in every aspect. Those who have read the pleasant book of Mr. Watson, who, as English chaplain for some years at Tokio, had exceptional opportunities of travel in the interior, will remember how often he met with shrines and temples on the summits of the mountains, and how he found pilgrims who frequented them in the belief that they fell there more readily into spiritual trances. The Japanese Minister, when he attended Mr. Watson's lecture at the Alpine Club, told us that his countrymen never climbed mountains without a serious—that is to say, a religious—object.

India and China would add to my evidence had I knowledge and time enough to refer to their literature. I remember Tennyson pointing out to me in a volume of translations from the Chinese a poem, written about the date of King Alfred, in praise of a picture of a mountain landscape. But I must return to the sixteenth and seventeenth centuries in Europe; I may go earlier—even back to Dante. His allusions to mountain scenery are frequent; his Virgil had all the craft of an Alpine rock-climber. Read Leonardo da Vinci's "Notes," Conrad Gesner's "Ascent of Pilatus"; study the narratives of the Alpine precursors Mr. Coolidge has collected and annotated with admirable industry in the prodigious volume he has recently brought out.

It is impossible for me here to multiply proofs of my argument, to quote even a selection from the passages that show an authentic enthusiasm for mountains that may be culled from writers of various nations prior to A.D. 1600. I must content myself with the following specimens, which will probably be new to most of my hearers.

Benoît Marti was a professor of Greek and Hebrew at Bern, and a friend of the great Conrad Gesner (I call him great, for he combined the qualities of a man of science and a man of letters, was one of the fathers of botany as well as of mountaineering, and was, in his many-sidedness, a typical figure of the Renaissance). Marti, in the year 1558 or 1559, wrote as follows of the view from his native city:—

"These are the mountains which form our pleasure and delight" (the Latin is better—"deliciæ nostræ, nostrique

amores ") "when we gaze at them from the higher parts of our city and admire their mighty peaks and broken crags that threaten to fall at any moment. Here we watch the risings and settings of the sun and seek signs of the weather. In them we find food not only for our eyes and our minds but also for our bellies"; and he goes on to enumerate the dairy products of the Oberland and the happy life of its population. I quote again this good man: "Who, then, would not admire, love, willingly visit, explore, and climb places of this sort? I assuredly should call those who are not attracted by them mushrooms, stupid, dull fishes, and slow tortoises" ("fungos, stupidos insulsos pisces, lentosque chelones"). "In truth, I cannot describe the sort of affection and natural love with which I am drawn to mountains, so that I am never happier than on the mountain crests, and there are no wanderings dearer to me than those on the mountains." "They are the theatre of the Lord, displaying monuments of past ages, such as precipices, rocks, peaks and chasms, and never-melting glaciers"; and so on through many eloquent paragraphs.

I will only add two sentences from the preface to Simler's "Vallesiæ et Alpium Descriptio," first published in 1574, which seem to me a strong piece of evidence in favour of my view:—"In the entire district, and particularly in the very lofty ranges by which the Vallais is on all sides surrounded, wonders of Nature offer themselves to our view and admiration. With my countrymen many of them have through familiarity lost their attraction; but foreigners are overcome at the mere sight of the Alps, and regard as marvels what we through habit pay no attention to."

Mr. Coolidge, in his singularly interesting footnotes, goes on to show that the books that remain to us are not isolated instances of a feeling for mountains in the age of the Renaissance. The mountains themselves bear, or once bore, records even more impressive. Most of us have climbed to the picturesque old castle at Thun and seen beyond the rushing Aar the green heights of the outposts of the Alps, the Stockhorn, and the Niesen. Our friend Marti, who climbed the former peak about 1558, records that he found on the summit "tituli, rythmi, et proverbia saxis inscripta unà cum imaginibus et nominibus auctorum. Inter alia cujusdam docti et montium amœnitate capti observare licebat illud:

"Ὁ τῶν ὀρῶν ἔρως ἄριστος."

"The love of mountains is best." In those five words some Swiss professor anticipated the doctrine of Ruskin and the creed of Leslie Stephen, and of all men who have found mountains the best companions in the vicissitudes of life.

In the annals of art it would be easy to find additional proof of the attention paid by men to mountains three to four hundred years ago. The late Josiah Gilbert, in a charming but too little-known volume, "Landscape in Art," has shown how many great painters depicted in their backgrounds their native hills. Titian is the most conspicuous example.

It will perhaps be answered that this love of mountains led to no practical result, bore no visible fruit, and therefore can have been but a sickly plant. Some of my hearers may feel inclined to point out that it was left to the latter half of the nineteenth century to found Climbers' Clubs. It would take too long to adduce all the practical reasons which delayed the appearance of these fine fruits of peace and an advanced civilisation. I am content to remind you that the love of mountains and the desire to climb them are distinct tastes. They are often united, but their union is accidental, not essential. A passion for golf does not necessarily argue a love of levels. I would suggest that more outward and visible signs than are generally imagined of the familiar relations between men and mountains in early times may be found. The choicest spots in the Alpine region—Chamonix, Engelberg, Disentis, Einsiedlen, Pesio, the Grande Chartreuse—were seized on by recluses; the Alpine Baths were in full swing at quite an early date. I will not count the Swiss Baden, of which a geographer, who was also a Pope, Æneas Silvius (Pius II.) records the attractions, for it is in the Jura, not the Alps; but Pfäfers, where wounded warriors went to be healed, was a scene of dissipation, and the waters of St. Moritz were vaunted as superseding wine. I may be excused, since I wrote this particular passage myself a good many years ago, for quoting a few sentences bearing on this point from "Murray's Handbook to Switzerland." In the sixteenth century fifty treatises dealing with twenty-one different resorts were published. St. Moritz, which had been brought into notice by Paracelsus (died 1541), was one of the most famous baths. In 1501 Matthew Schinner, the famous Prince Bishop of Sion, built "a magnificent hotel" at Leukerbad, to which the wealthy were carried up in panniers on the backs of mules. Brieg, Gurnigel, near Bern, the Baths of Masino, Tarasp, and Pfäfers were also popular in early times. Leonardo da Vinci mentions the baths of Bormio, and Gesner went there.

It is not, however, with the emotional influences or the picturesque aspect of mountains that science concerns itself, but with their physical examination. If I have lingered too long on my preamble I can only plead as an excuse that a love of one's subject is no bad qualification for dealing with it, and that it has tempted me to endeavour to show you grounds for believing that a love of mountains is no modern affectation, but a feeling as old and as widespread as humanity.

Their scientific investigation has naturally been of comparatively modern date. There are a few passages about the effects of altitude, there are orographical descriptions more or less accurate in the authors of antiquity. But for attempts to explain the origin of mountains, to investigate and account for the details of their structure, we shall find little before the notes of Leonardo da Vinci, that marvellous man who combined, perhaps, more than anyone who has ever lived the artistic and the scientific mind. His ascent of Monte Boso about 1511, a mountain which may be found under this name on the Italian ordnance map on the spur separating Val Sesia and the Biellese, was the first ascent by a physical observer. Gesner with all his mountain enthusiasm found a scientific interest in the Alps mainly if not solely in their botany.

The phenomenon which first drew men of science to Switzerland was the Grindelwald glaciers—"miracles of Nature" they called them. Why these glaciers in particular, you may ask, when there are so many in the Alps? The answer is obvious. Snow and ice on the "mountain tops that freeze" are no miracle. But when two great tongues of ice were found thrusting themselves down among meadows and corn and cottages, upsetting barns and covering fields and even the marble quarries from which the citizens of Bern dug their mantelpieces, there was obviously something outside the ordinary processes of Nature, and therefore miraculous.

Swiss correspondents communicated with our own Royal Society the latest news as to the proceedings of these unnatural ice-monsters, while the wise men of Zürich and Bern wrote lectures on them. Glacier theories began. Early in the eighteenth century Hottinger, Cappeller, Scheuchzer, that worthy man who got members of our Royal Society to pay for his pictures of flying dragons, contributed their quota of crude speculation. But it was not until 1741 that Mont Blanc and its glaciers were brought into notoriety by our young countrymen, Pococke and Windham, and became an attraction to the mind and an object to the ambition of the student whose name was destined to be associated with them. Horace Benedict de Saussure, born of a scientific family, the nephew of Bonnet, the Genevese botanist and philosopher, who has become known to the world as a mountaineer and the climber of Mont Blanc, came twenty years later. In truth he was far more of a mountain traveller and a scientific observer, a geological student, than a climber. When looking at his purple silk frock-coat (carefully preserved in his country house on the shore of the Lake of Geneva), one realises the difference between the man who climbed Mont Blanc in that garment and the modern gymnast, who thinks himself *par excellence* the mountaineer.

De Saussure did not confine himself to Savoy or to one group, he wandered far and wide over the Alpine region, and the four volumes of his "Voyages" contain, besides the narratives of his sojourn on the Col du Géant and ascent of Mont Blanc, a portion of the fruit of these wanderings.

The reader who would appreciate De Saussure's claim as the founder of the Scientific Exploration of Mountains must, however, be referred to the List of Agenda on questions calling for investigation placed at the end of his last volume.

They explain the comparative indifference shown by De Saussure to the problems connected with glacial movement and action. His attention was absorbed in the larger question of earth-structure, of geology, to which the sections exposed by mountains offered, he thought, a key; he was bitten by the contemporary desire for "A Theory of the Earth," by the taste of the time for generalisations for which the facts were not always ready. At the same time, his own intellect was perhaps somewhat deficient in the intuitive faculty; the grasp of the possible or probable bearing of known facts by which the greatest discoverers suggest theories first and prove them afterwards.

The school of De Saussure at Geneva died out after having produced Bourrit, the tourist who gloried in being called the Historian of the Alps, a man of pleasant self-conceit and warm enthusiasm, and De Luc, a mechanical inventor, who ended his life as reader to Queen Charlotte at Windsor, where he flits across Miss Burney's pages as the friend of Herschel at Slough and the jest of tipsy Royal Dukes. Oddly enough, the first sound guess as to glacier movement was made by one Bordier, who had no scientific pretensions. I reprinted many years ago the singular passage in which he compared glacier ice to "cire amollie," soft wax, "flexible et ductile jusqu'à un certain point," and described it as flowing in the manner of liquids (*Alp. J.*, ix. 327). He added this remarkable suggestion foreshadowing the investigations of Prof. Richter and M. Forel: "It is very desirable that there should be at Chamonix someone capable of observing the glaciers for a series of years and comparing their advance and oscillations with meteorological records." To the school of Geneva succeeded the school of Neuchatel, Desor and Agassiz; the feat of De Saussure was rivalled on the Jungfrau and the Finsteraarhorn by the Meyers of Bern. They in turn were succeeded by the British school, Forbes and Tyndall, Reilly and Wills, in 1840-60.

In 1857 the Alpine Club was founded in this country. In the half-century since that date the nations of Western Europe have emulated one another in forming similar bodies, one of the objects of which has been to collect and set in order information as to the mountains and to further their scientific as well as their geographical exploration.

What boulders, or rather pebbles, can we add to the enormous moraine of modern Alpine literature—a moraine the lighter portions of which it is to be hoped for the sake of posterity that the torrent of Time may speedily make away with?

For fifty years I have loved and at frequent intervals wandered and climbed in the Alps. I have had something of a grand passion for the Caucasus. I am on terms of visiting acquaintance with the Pyrenees and the Himalaya, the Apennines and the Algerian Atlas, the mountains of Greece, Syria, Corsica, and Norway. I will try to set in order some observations and comparisons suggested by these various experiences.

As one travels east from the Atlantic through the four great ranges of the Old World the peaks grow out not only in absolute height but also in abruptness of form, and in elevation above the connecting ridges. The snow and ice region increases in a corresponding manner. The Pyrenees have few fine rockpeaks except the Pic du Midi d'Ossau; its chief glacier summits, the Vignemale, Mont Perdu, the Maladetta, correspond to the Titlis or the Buet in the Alps. The peaks of the Alps are infinite in their variety and admirable in their clear-cut outlines and graceful curves. But the central group of the Caucasus, that which culminates in Dykhtau, Koshtantau, and Shkara, 17,000 feet summits (Koshtantau falls only 120 feet below this figure) has even more stately peaks than those that cluster round Zermatt.

Seek the far eastern end of the Himalaya, visit Sikkim, and you will find the scale increased; Siniolchum, Jannu, and Kangchenjunga are all portentous giants. To put it at a low average figure, the cliffs of their final peaks are half as high again as those of Monte Rosa and the Matterhorn.

In all these chains you will find the same feature of watersheds or partings lying not in but behind the geological axis, which is often the line of greatest peak elevation. This is the case in the Alps at the St. Gothard, in the Caucasus for some forty miles west of the Dariel Pass, in the Himalaya, in Sikkim and Nepal, where the waters flowing from the Tibetan plateau slowly eat their way back behind Kangchenjunga and the Nepalese snows. The passes at their sources are found consequently to be of the mildest character, hills "like Wiltshire Downs" is the description given by a military explorer. It needs no great stretch of geological imagination to believe in the cutting back of the southern streams of Sikkim or the Alps, as for instance at the Maloya, but I confess that I cannot see how the gorges of Ossetia, clefts cut through the central axis of the Caucasus, can be ascribed mainly to the action of water.

I turn to the snow and ice region. Far more snow is deposited on the heights of the Central Caucasus and the Eastern Himalaya than on the Alps. It remains plastered on their precipices, forming hanging glaciers everywhere of the kind found on the northern, the Wengern Alp, face of the Jungfrau. Such a peak as the Weisshorn looks poor and bare compared with Tetnuld in the Caucasus or Siniolchum in the Himalaya. The plastered sheets of snow between their great bosses of ice are perpetually melting, their surfaces are grooved, so as to suggest fluted armour, by tiny avalanches and runnels.

In the Aletsch glacier the Alps have a champion with which the Caucasus cannot compete; but apart from this single exception the Caucasian glaciers are superior to the Alpine in extent and picturesqueness. Their surfaces present the features familiar to us in the Alps—icefalls, moulins, and earthcones.

In Sikkim, on the contrary, the glaciers exhibit many novel features due no doubt mainly to the great sun-heat. In the lower portion their surface is apt to be covered with the débris that has fallen from the impending cliffs, so that little or no ice is visible from any distance. In the region below the névé there are very few crevasses, the ice heaves itself along in huge and rude undulations, high gritty mounds, separated by hollows often occupied by yellow pools which are connected by streams running in little icy ravines; a region exceptionally tiresome, but in no way dangerous to the explorer. In steep places the Alpine icefall is replaced by a feature I may best compare with a series of earth-pillars such as are found near Evolena and elsewhere, and are figured in most text-books. The ice is shaped into a multitude of thin ridges and spires, resembling somewhat the Nieves Penitentes of the Andes—though formed in a different material.

Great sun-heat acting on surfaces unequally protected, combined in the latter case with the strain of sudden descent, is no doubt the cause of both phenomena. Generally the peculiarities of the great glaciers of Kangchenjunga may be attributed to a vertical sun, which renders the frozen material less liable to crack, less rigid, and more plastic.

A glacier, as a rule, involves a moraine. Now moraines are largely formed from the material contributed by subaërial denudation, in plain words by the action of heat and cold and moisture on the cliffs that border them. It is what falls on a glacier, not that which it falls over, that mainly makes a moraine. The proof is that the moraines of a glacier which flows under no impending cliffs are puny compared with those of one that lies beneath great rock-walls.

Take, for example, the Norwegian glaciers of the Jostedals Brae and compare them with the Swiss. The former, falling from a great névé plain or snowfield, from which hardly a crag protrudes, are models of cleanliness. I may cite as examples the three fascinating glaciers of the Olden Valley. The Rosenlaui Glacier in Switzerland owed the cleanliness which gave it a reputation fifty years ago, before its retirement from tourists' tracks, to a similar cause—a vast snow-plateau, the Wetterkessel.

One peculiarity very noticeable both in the Himalaya and the Caucasus I have never found satisfactorily accounted for. I refer to the long grassy trenches lying between the lateral moraine and the hillside, which often seem to the mountain explorer to have been made by Providence to form grass paths for his benefit. They may possibly be due to the action of torrents falling from the hillside, which, meeting the moraine and constantly sweeping along its base, undermine it and keep a passage open for themselves. There are remarkable specimens of this formation on both sides of the Bezingi Glacier, in the Caucasus, and on the north side of the Zemu Glacier, in Sikkim.

Water is one of the greatest features in mountain scenery.

in Norway it is omnipresent. In this respect Scandinavia is a region apart; the streams of the more southern ranges are scanty compared with those of a region where the snowfall of two-thirds of the year is discharged in a few weeks. Greece stands at the opposite pole. By what seems a strange perversity of Nature, its slender streams are apt to disappear underground, to re-issue miles away in the great fountains that gave rise to so many legends. Arcadia is, for the most part, a dry upland, sadly wanting in the two elements of pastoral scenery, shady groves, and running brooks.

The Alps are distinguished by their subalpine lakes—

> "Anne lacus tantos? te, Lari maxime, teque,
> Fluctibus et fremitu assurgens, Benace, marino?"

of Virgil. But perhaps even more interesting to the student are the lake basins that have been filled up, and thus suggest how similar lakes may have vanished at the base of other ranges.

I know no more striking walk to anyone interested in the past doings of glaciers than that along the ridge of the mighty moraine of the old glacier of Val d'Aosta, which sweeps out, a hill 500 feet high, known as "La Serra," from the base of the Alps near Ivrea into the plain of Piedmont. Enclosed in its folds still lies the Lago di Viverone; but the Dora has long ago cut a gap in the rampart and drained the rest of the enclosed space, filling it up with the fluvial deposit of centuries.

It is, however, the tarns rather than the great lakes of the Alps which have been the chief subjects of scientific disputation. Their distribution is curious. They are found in great quantity in the Alps and Pyrenees, hardly at all in the Caucasus, and comparatively rarely in the part of the Himalaya I am acquainted with.

A large-scale map will show that where tarns are most thickly dotted over the uplands the peaks rise to no great height above the ridges that connect them. This would seem to indicate that there has been comparatively little subaërial denudation in these districts, and consequently less material has been brought down to fill the hollows. Again, it is in gneiss and granitic regions that we find tarns most abundant—that is, where the harder and more compact rocks make the work of streams in tapping the basins more lengthy. The rarity of tarns in the highlands behind Kangchenjunga, perhaps, calls for explanation. We came upon many basins, but, whether formed by moraines or true rockbasins, they had for the most part been filled up by alluvial deposits.

In my opinion, the presence of tarns must be taken as an indication that the portion of the range where they are found has until a comparatively recent date been under snow or ice. The former theory, still held, was that the ice scooped out their basins from the solid rock. I believe that it simply kept scoured pre-existing basins. The ice removed and the surrounding slopes left bare, streams on the one hand filled the basins with sediment, or, on the other, tapped them by cutting clefts in their rims. This theory meets, at any rate, all the facts I have observed, and I may point out that the actual process of the destruction of tarns by such action may be seen going on under our eyes in many places, notably in the glens of the Adamello group. Prof. Garwood has lately employed his holidays in sounding many of the tarns of the St. Gotthard group, and his results, I understand, tend to corroborate the conclusions stated.

I desire here to re-affirm my conviction that snow and ice in the High Alps are conservative agents: that they arrest the natural processes of subaërial denudation; that the scouring work done by a glacier is insignificant compared with the hewing and hacking of frost and running water on slopes exposed to the open sky without a roof of névé and glacier.

The contrast between the work of these two agents was forced upon me many years ago while looking at the ground from which the Eiger Glacier had then recently retreated. The rocks, it is true, had had their angles rubbed off by the glacier, but through their midst, cut as by a knife, was the deep slit or gash made by the subglacial torrent. There is in the Alps a particular type of gorge, found at Rosenlaui, at the Lower Grindelwald Glacier, at the Kirchet above Meiringen, and also in the Caucasus, within the curves of old terminal moraines. It is obviously due to the action of the subglacial torrent, which cuts deeper and deeper while the ice above protects the sides of the cutting from the effects of the atmosphere.

One more note I have to make about glaciers. It has been stated that glaciers go on melting in winter. Water, no doubt, flows from under some of them, but that is not the same thing. The end of the Rosenlaui Glacier is dry in January; you can jump across the clear stream that flows from the Lower Grindelwald glacier. That stream is not meltings, but the issue of a spring which rises under the glacier and does not freeze. There is another such stream on the way to the Great Scheideck, which remains free when frost has fettered all its neighbours.

I should like to direct your attention before we leave glaciers to the systematic efforts that are being made on the Continent to extend our knowledge of their peculiarities. The subject has a literature of its own, and two Societies—one in France, one in other countries—have been constituted to promote and systematise further investigations, especially with regard to the secular and annual oscillations of the ice. These were initiated by the English Alpine Club in 1893, while I was its president. Subsequently, through the exertions of the late Marshall Hall, an enthusiast on the subject, an International Commission of Glaciers was founded, which has been presided over by Dr. Richter, M. Forel, and others; and more recently a French Commission has been created with the object of studying in detail the glaciers of the French Alps. A number of excellent reports have been published, embodying information from all parts of the globe. There has been, and is, I regret to say, very great difficulty in obtaining any methodical reports from the British possessions oversea. The subject does not commend itself to the departmental mind. Let us hope for improvement: I signalise the need for it. Of course, it is by no means always an easy matter to get the required measurements of retreat or advance in the glacial snout, when the glacier is situated in a remote and only casually visited region. Still, with good-will more might be done than has been. The periods of advance and retreat of glaciers appear to correspond to a certain extent throughout the globe. The middle of the last century was the culmination of the last great advance. The general estimate of their duration appears to be half a century. The ice is now retreating in the Alps, the Caucasus, and the Himalaya, and I believe in North America. We live in a retrogressive period. The minor oscillation of advance which a few years ago gave hopes to those who, like myself, had as children seen the glaciers of Grindelwald and Chamonix at their greatest, has not been carried on.

Attempts are made to connect the oscillations of glaciers with periods of sun-spots. They are, of course, connected with the rain or snow-fall in past seasons. But the difficulty of working out the connection is obvious.

The advance of the ice will not begin until the snows falling in its upper basin have had time to descend as ice and become its snout; in each glacier this period will vary according to its length, bulk, and steepness, and the longer the glacier is, the slower its lower extremity will be to respond. Deficiency in snowfall will take effect after the same period. It will be necessary, therefore, to ascertain (as has been done in a tragic manner on Mont Blanc by the recovery in the lowest portion of the Glacier des Bossons of the bodies of those lost in its highest snows) the time each glacier takes to travel, and to apply this interval to the date of the year with which the statistics of deposition of moisture are to be compared. If the glacier shows anything about weather and climate, it is past, not contemporary, weather it indicates.

Another point in which the Asiatic ranges, and particularly the Himalaya, differ from the Alps is in the frequency of snow avalanches, earthfalls, and mud-slides. These are caused by the greater deposition of snow and the more sudden and violent alternations of heat and cold, which lead to the splitting of the hanging ice and snows by the freezing of the water in their pores. I have noticed at a bivouac that the moment of greatest cold—about the rising of the morning star—is often hailed by the reports of a volley of avalanches.

The botanist may find much to do in working out a comparison of the flora of my four ranges. I am no

botanist: I value flowers according, not to their rarity, but to their abundance, from the artist's, not the collector's, point of view. But it is impossible not to take interest in such matters as the variations of the gentian in different regions, the behaviour of such a plant as the little Edelweiss (once the token of the Tyrolese lover, now the badge of every Alp-trotter), which frequents the Alps, despises the Caucasus, reappears in masses in the Himalaya, and then, leaping all the isles of the tropics, turns up again under the snows of New Zealand. I may mention that it is a superstition that it grows only in dangerous places. I have often found it where cows can crop it; it covers acres in the Himalaya, and I believe it has been driven by cows off the Alpine pastures, as it is being driven by tourists out of the Alps altogether.

The Italian botanists, MM. Levier and Sommier, have given a vivid account of what they call the Makroflora of the Central Caucasus—those wild-flower beds, in which a man and horse may literally be lost to sight, the product of sudden heat on a rich and sodden soil composed of the vegetable mould of ages. Has any competent hand celebrated the Mikroflora of the highest ridges, those tiny, vivid forget-me-nots and gentians and ranunculuses that flourish on rock-island "Jardins" like that of Mont Blanc, among the eternal snows, and enamel the highest rocks of the Basodano and the Lombard Alps? A comprehensive work on a comparison of mountain flora and the distribution of Alpine plants throughout the ranges of the Old World would be welcome. We want another John Ball. Allied to botany is forestry, and the influence of trees on rainfall, and consequently the face of the mountains, a matter of great importance, which in this country has hardly had the attention it deserves.

From these brief suggestions as to some of the physical features of mountains I would ask you to turn your attention to the points in which mankind come in contact with them, and first of all to History.

I fancy that the general impression that they have served as efficient barriers is hardly in accordance with facts, at any rate from the military point of view. Hannibal, Cæsar, Charles the Great, and Napoleon passed the Alps successfully. Hannibal, it is true, had some difficulty, but then he was handicapped with elephants. The Holy Roman Emperors constantly moved forwards and backwards. Burgundy, as the late Mr. Freeman was never weary of insisting, lay across the Alps. So until our own day did the dominions of the House of Savoy. North Italy has been in frequent connection with Germany; it is only in my own time that the Alps have become a frontier between France and Italy. But questions of this kind might lead us too far. Let me suggest that some competent hand should compose a history of the Alpine passes and their famous passages, more complete than the treatises that have appeared in Germany. Mr. Coolidge, to whom we owe so much, has, in his monumental collection and reprint of early Alpine writers, just published, thrown great light on the extensive use of what I may call the by-passes of the Alps in early times. Will he not follow up his work by treating of the Great Passes? I may note that the result of the construction of carriage roads over some of them was to concentrate traffic; thus the Monte Moro and the Gries were practically deserted for commercial purposes when Napoleon opened the Simplon. The roads over the Julier and Maloya ruined the Septimer. Another hint to those engaged in tracing ancient lines of communication. In primitive times, in the Caucasus to-day, the tendency of paths is to follow ridges, not valleys. The motives are on the spot obvious—to avoid torrents, swamps, ravines, earthfalls, and to get out of the thickets and above the timberline. The most striking example is the entrance to the great basin of Suanetia, which runs not up its river, the Ingur, but over a ridge of nearly 9000 feet, closed for eight months in the year to animals.

From the military point of view mountains are now receiving great attention in Central Europe. The French, the Italians, the Swiss, the Austrians have extensive Alpine manœuvres every summer, in which men, mules, and light artillery are conveyed or carried over rocks and snow. Officers are taught to use maps on the spot, the defects in the official surveys are brought to light. It is not likely, perhaps, except on the Indian frontier, that British troops will have to fight among high snowy ranges. But I feel sure that any intelligent officer who is allowed to attend such manœuvres might pick up valuable hints as to the best equipment for use in steep places. Probably the Japanese have already sent such an envoy and profited by his experience.

A word as to maps, in which I have taken great interest, may be allowed me. The ordnance maps of Europe have been made by soldiers, or under the supervision of soldiers. At home when I was young, it was dangerous to hint at any defects in our ordnance sheets, for surveyors in this country are a somewhat sensitive class. Times have altered, and they are no longer averse from receiving hints and even help from unofficial quarters. Since the great surveys of Europe were executed, knowledge has increased so that every country has had to revise or to do over again its surveys. In three points that concern us there was great room for improvement, the delineation of the upper region as a whole, and the definition of snow and glaciers in particular, and in the selection of local names. In the two former the Federal Staff at Bern has provided us with an incomparable model. The number of local names known to each peasant is small, his pronunciation is often obscure, and each valley is apt to have its own set of names for the ridges and gaps that form its skyline. Set a stranger, speaking another tongue than the local *patois*, to question a herdsman, and the result is likely to be unsatisfactory. It has often proved so. The Zardezan is an odd transcription of the Gias del Cian of *patois*, the Gîte du Champ in French. The Grand Paradis is the last term an Aostan peasant would have used for the Granta Parei, the great screen of rock and ice of the highest mountain in Italy. The Pointe de Rosablanche was the Roesa Bianca, or white glacier. Monte Rosa herself, though the poet sees a reference to the rose of dawn, and the German professor detects "the Keltic *ros*, a promontory," is a simple translation of the Gletscher Mons of Simler, or rather Simler's hybrid term is a translation of Monte della Roesa. Roesa, or Ruize, is the Val d'Aostan word for glacier, and may be found in De Saussure's "Voyages."

An important case in this matter of mountain nomenclature has recently come under discussion—that of the highest mountain in the world. Most, if not all, mountaineers regret that the name of a Surveyor-General, however eminent, was fifty years ago affixed to Mount Everest. The ground for this action on the part of the Survey was the lack of any native name. Some years ago I ventured to suggest that the 29,002-feet peak (No. XV. of the Survey) was probably visible from the neighbourhood of Katmandu, even though the identifications of it by Schlagintweit and others might be incorrect, and that since some at least of the summits of the snowy group east of that city are apparently known in Nepal as Gaurisankar, that name might, following the practice which gave its name to Monte Rosa in the Alps, legitimately be applied to the loftiest crest of the mountain group of which the Nepalese Gaurisankar formed a part.

Recently, by the kindness of Lord Curzon, acting on a suggestion of my own, Captain Wood, a Survey officer, has been deputed to visit Katmandu and ascertain the facts. He has found that, contrary to the opinion of the late General Walker and the assertion of Major Waddell, Peak XV. is visible from the hills round the capital, and that the two highest snowpeaks visible from the city itself in the same direction were known to the Nepalese "nobles" as Gaurisankar.

These latter peaks or peak are about 36 miles distant from Peak XV., but are connected with it by a continuous line of glaciers. According to the principles that have prevailed in the division of the Alps, they would undoubtedly be considered as part of the same group, and the name, which, according to Captain Wood, is applied to a portion of the group, might legitimately be adopted for its loftiest peak.

But the chiefs of the Indian Survey take, as they are entitled to, a different view. They have decided to confine the name Gaurisankar to one of the peaks seen from Katmandu itself. I do not desire to raise any further protest against this decision. For since, in 1886, I first raised the question its interest has become mainly academical. A local Tibetan name for Peak XV., Chomo-Kankar, the Lord of Snows, has been provided on excellent native authority, confirmed by that competent Tibetan scholar, Major

Waddell, and I trust this name may in the future be used for the highest mountain in the world.[1] The point at issue is mainly one of taste. Indian surveyors may see no incongruity in naming after one of their own late chiefs the highest mountain in the world. But in this view they are, I believe, in a small minority.

I would urge mountain explorers to attempt in more distant lands what the late Messrs. Adams-Reilly and Nichols, Mr. Tuckett, and Lieut. Payer (of Arctic fame) did forty years ago with so much success in the Alps, what the Swiss Alpine Club have done lately, take a district, and working from the trigonometrically fixed points of a survey, where one exists, fill it in by planetabling with the help of the instruments for photographic and telephotographic surveying, in the use of which Mr. Reeves, the map curator to the R.G.S., is happy to give instruction. An excellent piece of work of this kind has been done by Mr. Stein in Central Asia.

There are, I know, some old-fashioned persons in this country who dispute the use of photography in mountain work. It can only be because they have never given it a full and fair trial with proper instruments.

Lastly, I come to a matter on which we may hope before long to have the advantage of medical opinion, based for the first time on a large number of cases. I refer to the effects of high altitudes on the human frame and the extent of the normal diminution in force as men ascend. The advance to Lhasa ought to do much to throw light on this interesting subject. I trust the Indian Government has taken care that the subject shall be carefully investigated by experts. The experience of most mountaineers (including my own) in the last few years has tended to modify our previous belief that bodily weakness increases more or less regularly with increasing altitude. Mr. White, the Resident in Sikkim, and my party both found on the borders of Tibet that the feelings of fatigue and discomfort that manifested themselves at about 14,000 to 16,000 feet tended to diminish as we climbed to 20,000 or 21,000 feet. I shall always regret that when I was travelling in 1899 on the shoulders of Kangchenjunga the exceptional snowfall altogether prevented me from testing the point at which any of our ascents were stopped by discomforts due to the atmosphere. Owing to the nature of the footing, soft snow lying on hard, it was more difficult to walk uphill than on a shingly beach; and it was impossible for us to discriminate between the causes of exhaustion.

Here I must bring this, I fear, desultory Address to an end. I might easily have made it more purely geographical, if it is geography to furnish a mass of statistics that are better and more intelligibly given by a map. I might have dwelt on my own explorations in greater detail, or have summarised those of my friends of the Alpine Club. But I have done all this elsewhere in books or reviews, and I was unwilling to inflict it for a second time on any of my hearers who may have done me the honour to read what I have written. Looking back, I find I have been able to communicate very little of value, yet I trust I may have suggested to some of my audience what opportunities mountains offer for scientific observations to mountaineers better qualified in science than the present speaker, and how far we scouts or pioneers are from having exhausted even our Alpine playground as a field for intelligent and systematic research.

And even if the value to others of his travels may be doubtful, the Alpine explorer is sure of his reward. What has been said of books is true also of mountains—they are the best of friends. Poets and geologists may proclaim—

> "The hills are shadows, and they flow
> From form to form, and nothing stands!"

But for us creatures of a day the great mountains stand fast, the Jungfrau and Mont Blanc do not change. Through all the vicissitudes of life we find them sure and sympathetic companions. Let me conclude with two lines which I found engraved on a tomb in Santa Croce at Florence:

> "Huc properate, viri, salebrosum scandite montem,
> Pulchra laboris erunt præmia, palma, quies."

[1] See, for discussions of this question, *Proceedings* of the Royal Geographical Society, N.S., 1885, vii., 753; 1886, viii., 88, 176, 257; *Geographical Journal*, 1903, xxi., 294; 1904, xxiii., 89; *Alpine Journal*, 1886, xii., 448; 1902-3, xxi., 33, 317; *Petermann's Mitteilungen*, 1888, xxxiv., 338; 1890, xxxvi., 251; 1901, xlvii., 40; 1902, xlviii., 14.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY HON. CHARLES A. PARSONS, M.A., F.R.S., M.INST.C.E., PRESIDENT OF THE SECTION.

On this occasion I propose to devote my remarks to the subject of invention.

It is a subject of considerable importance, not only to engineers but also to men of science and the public generally.

I also propose to treat invention in its wider sense, and to include under the word discoveries in physics, mechanics, chemistry, and geology.

Invention throughout the Middle Ages was held in little esteem. In most dictionaries it receives scant reference except as applied to poetry, painting, and sculpture.

Shakespeare and Dryden describe invention as a kind of muse or inspiration in relation to the arts, and when taken in its general sense to be associated with deceit, as "Return with an invention, and clap upon you two or three plausible lies."

As to the opposition and hostility to scientific research, discovery, and mechanical invention in the past, and until comparatively recent times, there can be no question, in some cases the opposition actually amounting to persecution and cruelty.

The change in public opinion has been gradual. The great inventions of the last century in science and the arts have resulted in a large increase of knowledge and the powers of man to harness the forces of Nature. These great inventions have proved without question that the inventors in the past have, in the widest sense, been among the greatest benefactors of the human race. Yet the lot of the inventor until recent years has been exceptionally trying, and even in our time I scarcely think that anyone would venture to describe it as altogether a happy one. The hostility and opposition which the inventor suffered in the Middle Ages have certainly been removed, but he still labours under serious disability in many respects under law as compared with other sections of the community. The change of public feeling in favour of discovery and invention has progressed with rapidity during the last century. Not only have private individuals devoted more time and money to the work, but societies, institutions, colleges, municipalities, and Governments have founded many research laboratories, and in some instances have provided large endowments. These measures have increased the number of persons trained to scientific methods, and also provided greatly improved facilities for research; but perhaps one of the most important results to engineers has been the direct and indirect influence of the more general application of scientific methods to engineering.

Sir Frederick Bramwell, in his Presidential Address to this Association in 1888, emphasised the interdependence of the man of science and the civil engineer, and described how the work of the latter has been largely based on the discoveries of the former; while the work of the engineer often provides data and adds a stimulus to the researches of the man of science. And I think his remarks might be further appropriately extended by adding that since the man of science, the engineer, the chemist, the metallurgist, the geologist, all seek to unravel and to compass the secrets of Nature, they are all to a great extent interdependent on each other.

But though research laboratories are the chief centres of scientific invention, and colleges, institutions, and schools train the mind to scientific methods of attack, yet in mechanical, civil, and electrical engineering the chief work of practical investigation has been carried on by individual engineers, or by firms, syndicates, and companies. These not only have adapted discoveries made by men of science to commercial uses, but also in many instances have themselves made such discoveries or inventions.

To return to the subject, let us for a moment consider in what invention really consists, and let us dismiss from our minds the very common conception which is given in dictionaries and encyclopædias that invention is a happy thought occurring to an inventive mind. Such a conception would give us an entirely erroneous idea of the formation of the great steps in advance in science and engineering that have been made during the last century; and, further, it would lead us to forget the fact that almost all important

inventions have been the result of long training and laborious research and long-continued labour. Generally, what is usually called an invention is the work of many individuals, each one adding something to the work of his predecessors, each one suggesting something to overcome some difficulty, trying many things, testing them when possible, rejecting the failures, retaining the best, and by a process of gradual selection arriving at the most perfect method of accomplishing the end in view.

This is the usual process by which inventions are made.

Then after the invention, which we will suppose is the successful attempt to unravel some secret of Nature, or some mechanical or other problem, there follows in many cases the perfecting of the invention for general use, the realisation of the advance or its introduction commercially; this after-work often involves as great difficulties and requires for its accomplishment as great a measure of skill as the invention itself, of which it may be considered in many cases as forming a part.

If the invention, as is often the case, competes with or is intended to supersede some older method, then there is a struggle for existence between the two. This state of things has been well described by Mr. Fletcher Moulton. The new invention, like a young sapling in a dense forest, struggles to grow up to maturity, but the dense shade of the older and higher trees robs it of the necessary light. If it could only once grow as tall as the rest all would be easy, it would then get its fair share of light and sunshine. Thus it often occurs in the history of inventions that the surroundings are not favourable when the first attack is made, and that subsequently it is repeated by different persons, and finally in different circumstances it may eventually succeed and become established.

We may take in illustration almost any of the great inventions of undoubted utility of which we happen to have the full history—for instance, some of the great scientific discoveries, or some of the great mechanical inventions, such as the steam-engine, the gas-engine, the steamship, the locomotive, the motor-car, or some of the great chemical or metallurgical discoveries. Are not most, if not all, of these the result of the long-continued labour of many persons, and has not the financial side been, in most cases, a very important factor in securing success?

The history of the steam-engine might be selected, but I prefer on this occasion to take the internal-combustion engine, for two reasons—firstly, because its history is a typical one; and secondly, because we are to hear a paper by that able exponent and great inventor in the domain of the gas-engine, Mr. Dugald Clerk, describing not only the history, but the engine in its present state of development and perfection, an engine which is able to convert the greatest percentage of heat units in the fuel into mechanical work, excepting only, as far as we at present know, the voltaic battery and living organisms.

The first true internal-combustion engine was undoubtedly the cannon, and the use in it of combustible powder for giving energy to the shot is strictly analogous to the use of the explosive mixture of gas or oil and air as at present in use in all internal-combustion engines; thus the first internal-combustion engine depended on the combination of a chemical discovery and a mechanical invention, the invention of gunpowder and the invention of the cannon.

In 1680 Huygens proposed to use gunpowder for obtaining motive power in an engine. Papin, in 1690, continued Huygens's experiments, but without success. These two inventors, instead of following the method of burning the powder under pressure, as in the cannon, adopted, in ignorance of thermodynamic laws, an erroneous course. They exploded a small quantity of gunpowder in a large vessel with escape valves, which after the explosion caused a partial vacuum to remain in the vessel. This partial vacuum was then used to actuate a piston or engine and perform useful work. Subsequently several other inventors worked on the same lines, but all of these failed on account of two causes which now are very evident to us. Firstly, gunpowder was then, as it still is, a very expensive form of fuel, in proportion to the energy liberated on explosion; secondly, the method of burning the powder to cause a vacuum involves the waste of nearly the whole of the available energy, whereas had it been burned under pressure, as in the cannon, a comparatively large percentage of the energy would have been converted into useful work. But even with this alteration, and however perfect the engine had been, the cost of explosives would have debarred its coming into use, except for very special purposes.

We come a century later to the first real gas-engine. Street, in 1794, proposed the use of vapour of turpentine in an engine on methods closely analogous to those successfully adopted in the Lenoir gas-engine of eighty years later, or thirty years ago. But Street's engine failed from crude and faulty construction. Brown, in 1823, tried Huygens's vacuum method, using fuel to expand air instead of gunpowder, but he also failed, probably on account of the wastefulness of the method.

Wright, in 1833, made a really good gas-engine, having many of the essential features of some of the gas-engines of the present day, such as separate gas and water pumps, and water-jacketed cylinder and piston.

Barnett, in 1839, further improved on Wright's design, and made the greatest advance of any worker in gas-engines. He added the fundamental improvements of compression of the explosive mixture before combustion, and he devised means of lighting the mixture under pressure, and his engine conformed closely to the present-day practice as regards fundamental details. No doubt Barnett's engine, so perfect in principle, deserved commercial success, but either his mechanical skill or his financial resources were inadequate to the task, and the character of the patents would seem to favour this conclusion, both as regards Barnett and other workers at this period. Up to 1850 the workers were few, but as time went on they gradually increased in numbers; attention had been attracted to the subject, and men with greater powers and resources appear to have taken the problem in hand. Among these numerous workers came Lenoir, in 1860, who, adopting the inferior type of non-compression engine, made it a commercial success by his superior mechanical skill and resources. Mr. Dugald Clerk tells us: "The proposals of Brown (1823), Wright (1833), Barnett (1838), Bansanti and Matteucci (1857), show gradually increasing knowledge of detail and the difficulties to be overcome, all leading to the first practicable engine in 1866, the Lenoir." This stage of the development being reached, the names of Siemens, Beaude Roches, Otto Simon, Dugald Clerk, Priestman, Daimler, Dowson, Mond, and others, appear as inventors who have worked at and added something to perfect the internal-combustion engine and its fuel, and who have helped to bring it to its present state of perfection.

In the history of great mechanical inventions there is perhaps no better example of the interdependence of the engineer, the physicist, and the chemist than is evinced in the perfecting of the gas-engine. The physicist and the chemist together determine the behaviour of the gaseous fuel, basing their theory on data obtained from the experimental engines constructed by the mechanical engineer, who, guided by their theories, makes his designs and improvements; then, again, from the results of the improvements fresh data are collected and the theory further advanced, and so on until success is reached. But though I have spoken of the physicist, the chemist, and the engineer as separate persons, it more generally occurs that they are rolled into one, or at most two, individuals, and that it is indispensable that each worker should have some considerable knowledge of all the sciences involved to be able to act his part successfully.

Now let us ask, Could not this very valuable invention, the internal-combustion engine, have been introduced in a much shorter time by more favouring circumstances, by some more favourable arrangement of the patent laws, or by legislation to assist the worker attacking so difficult a problem? I think the answer is that a great deal might be done, and I will endeavour to indicate some changes and possible improvements.

The history of this invention brings before our minds two important considerations. Firstly, let us consider the patentable matter involved in the invention of the gas-engine, the utilisation for motive-power purposes of the then well known properties of the explosive energy of gunpowder or of mixtures of gas and oil with air. Are not these obvious inferences to persons of a mechanical turn of mind and who had seen guns fired, or explosions in bottles containing spirits of turpentine when slightly heated

and a light applied to the neck? Surely no fundamental patent could have been granted under the existing patent laws for so obvious an application of known forces. Consequently, patent protection was sought in comparative details, details in some cases essential to success which were evolved or invented in the process of working out the invention. In this extended field of operations a slight protection was in some instances obtained. But in answer to the question whether such protection was commensurate with the benefits received by the community at large, there can, I think, be only one reply. Generally, those who did most got nothing, some few received insufficient returns, and in very few cases indeed can the return be said to have been adequate. The second important consideration is that of the methods of procedure of the patentees, for it appears that very few of them had studied what had been suggested or done before by others before taking out their own patent. We are also struck by the number of really important advances that have been suggested and have failed to fructify, either from want of funds or other causes, to be forgotten for the time and to be re-invented later on by subsequent workers.

What a waste of time, expense, and disappointment would be avoided if we in England helped the patentee to find out easily what had been done previously, on the lines adopted by the United States and German Patent Offices, who advise the patentee after the receipt of his provisional specification of the chief anticipatory patents, dead or alive! And ought we in England to rest content to see our patentees awaiting the report of the United States and German Patent Offices on their foreign equivalent specifications before filing their English patent claims? Ought not our Patent Office to give more facilities and assistance to the patentee?

Before proceeding further to discuss some of the possible improvements for the encouragement and protection of research and invention, I ask you further to consider the position of the inventor—the man anxious to achieve success where others have hitherto failed. To be successful he must be something of an enthusiast; and usually he is a poor man, or a man of moderate means, and dependent on others for financial assistance. Generally the problem to be attacked involves a considerable expenditure of money; some problems require great expenditure before any return can thereby accrue, even in the most favourable circumstances. In the very few cases where the inventor has some means of his own they are generally insufficient to carry him through, and there have unfortunately been many who have lost everything in the attempt. In nearly all cases the inventor has to co-operate with capital: the capitalist may be a sleeping partner, or the capital may be held by a firm or syndicate, the inventor in such cases being a partner—a junior partner—or a member of the staff. The combination may be successful and lasting, but unfortunately the best inventors are often bad men of business. The elements of the combination are often unstable, and the disturbing forces are many and active; especially is this so when the problem to be attacked is one of difficulty, necessitating various and successive schemes involving considerable expenditure, generally many times greater than that foreshadowed at the commencement of the undertaking. In such circumstances, unless the capitalist or the senior partner or board be in entire sympathy with the inventor or exercise great forbearance, stimulated by the hope of ultimate success and adequate returns, the case becomes hopeless, disruption takes place, and the situation is abandoned. Further, in the majority of cases, after some substantial progress has been made it is found that under the existing patent laws insufficient protection can be secured, and the prospect of a reasonable return for the expenditure becomes doubtful. In such circumstances the capitalist will generally refuse to proceed further unless the prospect of being first in the field may tempt him to continue.

Very many inventors, as I have said, avoid the expense of searching the patent records to see how far their problem has been attacked by others. In some cases the cost of a thorough search is very great indeed; sometimes it is greater than the cost of a trial attack on the problem. In the case of young and inexperienced inventors there sometimes exists a disinclination to enter on an expensive search; they prefer to spend their money on the attack itself. There are some, it is true, who have a foolish aversion to take steps to ascertain if others have been before them, and who prefer to remain in ignorance and trust to chance. It will, however, be said that the United States and German Patent Office reports ought to suffice to warn or protect the English patentee; but my own experience has been that such protection is not entirely satisfactory. There is, firstly, a considerable interval before such reports are received, and the life of a patent is short. Then, if the patent is upon an important subject, attracting general attention, the search is vigorous and sometimes overwrought, and the patent unjustly damaged or refused altogether. If, however, the patent is on some subject not attracting general attention, it receives too little attention and is granted without comment.

In some few instances it may be said that ignorance has been a positive advantage, and that if the patentee had realised how much of his patentable work was honeycombed by previous publications and patents, he would have lost heart and given up the task. It is, I think, a case of the exception proving the rule; and the patentee ought, as far as possible, in all cases to know his true position, and make his choice accordingly. The present patent law has some curious anomalies. Let us suppose some inventor has the good fortune to place the keystone in the arch of an invention, to add some finishing touch which makes the whole invention a complete success, and valuable. Then, success having been proved possible, others try to reap the results of his labour and good fortune, and, as often happens, it is discovered after laborious search that someone else first suggested the same keystone in some long-forgotten patent or obscure publication, but for some reason or other the public were none the better for his having done so. What does the law do? It says this is an anticipation, and instead of apportioning to all parties reasonable and equitable shares in the perfected invention, to which no one could object, it says that the patent is injured or perhaps rendered useless by the anticipation, and that its value to everyone concerned is thereby diminished or destroyed, as the case may be, and thrown open to the public. Until a few years ago, any anticipations, however old, might be cited; but recently the law has been amended, and at present none rank as anticipations which are more than fifty years old.

The perfecting of inventions and their introduction into general use require capital, as we have seen—sometimes a considerable amount, as in the introduction of the Bessemer process for steel, or the linotype system of printing—before any commercial success can be realised.

Capital having been found, the next difficulty is in the conservatism of persons and communities who are the buyers of the invention. There is always present in their minds the risk of failure and its consequent loss and worry to themselves, and in the event of success the advantage, in their estimation, may not be sufficient to counterbalance the risk. In large departments and companies the management of which is conducted by officials receiving fixed salaries, acting under non-technical supervision, there is a strong tendency among the officials to leave well alone, the organisation being such that the risk of failure, even though it be remote, more than counterbalances, in their estimation, the advantages that would result in the event of success. Next is the opposition of those who are financially interested in competing trades or older inventions; and if the invention is a labour-saving appliance, then the active opposition of the displaced labour is a serious, though generally only a temporary, barrier.

Fortunately, however, for the community, for research, and for invention, there is always to be found a considerable percentage of persons who, apart from the inventor, are able and willing to risk, and indeed to sacrifice, their personal interests in the cause of progress for the benefit of the community at large; and were it not for such persons the task of the introduction of most inventions would be an impossible one.

There are many problems of the highest importance in physics, engineering, chemistry, geology, and the arts, of which the investigation might probably prove of great benefit to the human race, and of which the probable monetary cost of the attack would be considerable, and of some very great indeed. Let us, then, inquire how the necessary funds could be raised. It is possible in the case of some of the more attractive problems that a group of

rich philanthropists might be found, but in most cases it would be impossible to form a company on business lines, under the existing laws of this and other countries, as I shall endeavour to show.

In the case of many of the problems, no patents will give adequate protection; in some cases there is no subject-matter of novelty and importance involved. In other cases the probable duration of the investigation is so long that any initial patents would have expired before a commercial result was reached, and in either of these circumstances there would be no inducement to business men or financiers to undertake the risk.

As an illustration of my meaning I will take two investigations that have doubtless occurred to the minds of most of those present, though many others of greater or less importance might be cited. One is the thorough investigation of the problem of aërial navigation, with or without the assistance of flotation by gas. This problem could undoubtedly be successfully solved by an organised attack of skilled and properly trained engineers and the expenditure of a large sum of money. Assuming the problem solved, and commercially successful, it appears to be impossible under the existing patent laws to secure any adequate monopoly so as to justify the expectation of a reasonable return on the capital expended on the invention. For in view of the multitude of suggestions that have been made and the experiments that have been carried out, the practical solution of the problem would appear to rest on a judicious selection of old ideas by means of exhaustive experiments.

Another and perhaps more important investigation which has not, as yet, been attacked to any material extent is the exploration of the lower depths of the earth. At present the deepest shaft is, I believe, at the Cape, of a little more than one mile in depth, and the deepest bore-hole is one made in Silesia, by the Austrian Government, of about the same depth. What would be found at greater depths is at present a matter for conjecture, founded on the dip and thicknesses of strata observed on or near the surface. Much money and many valuable lives have been devoted to exploration of the polar regions, but there can be no comparison between the scientific interest and the possible material results of such exploration and the one I have chosen for illustration of the inadequate protection afforded by law—namely, a great engineering attack on a problem of geology.

I would ask you to consider the commercial aspect of this engineering geological enterprise, as compared with exploration into new or unknown areas on the surface of the earth.

An exploring expedition into a new country has before it generally the probability of the acquisition of territorial and mineral rights or possessions bringing material gain to the undertakers. The rights of such enterprises are well known, and capital can be obtained with or without national support, as the case may be. On the other hand, the explorer into the depths of the earth has no rights or monopolies beyond the mineral rights of the land he has purchased over his boring; further, it is improbable that he can obtain any patent of substantial value for his methods of boring to great depths. To succeed in the undertaking a great expenditure of money must be incurred, an expenditure far greater than that of an exploring expedition, and analogous to that of a military expedition or a small invading army, and to raise this sum the pioneers have practically no security to offer. For if they succeed in finding rich deposits of precious minerals in greater abundance, or succeed in making some geological discovery associated with deep borings, they gain no exclusive title to these under existing laws. Any other person or syndicate acting upon the experience gained, could sink other shafts in other places or countries, and, benefiting by the experience gained by the pioneers, could probably carry out the work more advantageously, and thus depreciate the first undertaking or render it valueless, as has often occurred before.

Let us consider more closely some of the essential features of sinking a shaft to a great depth, for I think it will be seen that it presents no unsurmountable difficulties beyond those incidental to an enterprise of considerable magnitude involving the ordinary methods of procedure and the ordinary methods adopted by mining engineers. That there would be some departures from ordinary practice on account of the great depth is true, but these are more of the character of detail. On the design of this boring I have consulted Mr. John Bell Simpson, the eminent authority on mining in the North of England. The shaft would be sunk in a locality to avoid as far as possible water-bearing strata and the necessity of pumping. It would be of a size usual in ordinary mines or coal-pits. The exact position of such shaft would require some consideration as to whether it should commence in the primary or secondary strata. It would be sunk in stages, each of about half a mile in depth, and at each stage there would be placed the hauling and other machinery, to be worked electrically, for dealing with each stage. The depth of each stage would be restricted to half a mile in order to avoid a disproportionate cost in the hauling machinery and the weight of rope, as well as increased cost in the cooling arrangements arising from excessive hydraulic pressures. At each second or third mile in depth there would be air-locks to prevent the air-pressure from becoming excessive owing to the weight of the superincumbent air, which at from two to three miles would reach about double the atmospheric pressure at the surface. A greater rise of pressure than this would be objectionable for two reasons—firstly, from the inconvenience to the workmen; secondly, from the rise of temperature due to the adiabatic compression of the circulating air for ventilating purposes. The air-pressure immediately above each air-lock would thus reach to about two atmospheres, and beneath to one atmosphere. In order to carry on the transfer of air through the air-locks for ventilating purposes pumps coupled to air-engines would be provided, the energy to work the pumps being obtained from electro-motors. To maintain the shaft at a reasonable temperature at the greater depth powerful means of carrying the heat to the surface would be provided.

The most suitable arrangement for cooling would probably consist of large steel pipes, an upcast and a downcast pipe, connected at the top and bottom of each half-mile section in a closed ring. This ring would be filled with brine, which by natural circulation would form a powerful carrier of heat; but the circulation, assisted by electrically driven centrifugal pumps, would be capable of carrying an enormous quantity of heat upwards to the surface. At each half-mile stage there would be a transfer of the heat from the ring below to the ring above by means of an apparatus similar in construction to a feed-water heater, or to a regenerator constructed of small steel tubes, through which the brine in the ring above would circulate, and around the outside the brine in the ring below could also circulate, the heat being transmitted through the metal of the tubes from brine ring to brine ring.

We have now presented to us two alternative arrangements for cooling. One arrangement would be to cool the brine to a very low temperature in the top ring at the mouth of the shaft by refrigerating machinery, so as to provide a sufficient gradation of temperature in the whole brine system, to ensure the necessary flow of heat upwards from brine ring to brine ring, and overcome all the resistances of heat-transfer, and so maintain the lowest ring at the temperature necessary for effectual cooling of the lowest section of the shaft. But a better arrangement would be to place powerful refrigerating machinery at certain of the lower stages, the function of this machinery being to extract heat from the ring below and deliver it to the ring above. This latter method would increase to a very great extent the heat-carrying power of the system, which in the first arrangement is limited by the freezing temperature of brine in the descending column and the highest temperature admissible in the ascending brine column. The amount of heat conducted inwards through the rock-wall and requiring to be absorbed and transferred to the surface depends on the temperature and conductibility of the strata. But there is no doubt that the methods I have indicated would be capable of maintaining a moderate temperature in the shaft to depths of twelve miles.

During the process of sinking at the greater depths the shaft bottom would require the application of a special cooling process in advance of the sinkers, similar to the Belgian freezing system of M. Poesche used for sinking through water-bearing strata and quicksands, and now in general use. It consists in driving a number of bore-holes in a circle outside the perimeter of the shaft to be sunk;

through these bore-holes very cold brine is circulated, thus freezing the rocks and quicksands and the water therein, and when this process is completed the sinking of the shaft is easily accomplished.

In our case this process would be maintained not only on the shaft bottom, but also for some time on the newly-pierced shaft sides, until the surrounding rock had been cooled for some distance from the face.

As to the cost, rate of boring, and normal temperature of the rock, an approximate estimate has been made, based on the experience gained on the Rand, but including the extra costs for air-locks and cooling:—

	Cost £	Time in Years	Temp. of Rock
For 2 miles depth from the surface.	500,000	10	122° F.
,, 4 ,, ,, ,, ,, ,, .	1,100,000	25	152°
,, 6 ,, ,, ,, ,, ,, .	1,800 000	40	182
,, 8 ,, ,, ,, ,, ,, .	2,700,000	55	212°
,, 10 ,, ,, ,, ,, ,, .	3,700,000	70	242°
,, 12 ,, ,, ,, ,, ,, .	5,000,000	85	272°

I hope I have succeeded in showing in the short time at our disposal that an exploration to great depths is not an impossible undertaking. But my main object in discussing the enterprise at some length has been to show that a pioneer company would not acquire any subsequent monopoly of similar works under the existing patent laws or the laws of any country.

In the scheme as I have described it, there appears to be nothing that could be patented; but let us suppose that some good patent could have been found that was absolutely essential to the success of the undertaking, it would certainly have expired before the pioneer company could have reaped any substantial return, and probably before the first enterprise had been completed. It follows therefore that at the present time there is no adequate protection, or indeed any protection at all, for the promoters of many great and important pioneer enterprises, some of which might prove of immense benefit to mankind.

Let us ask what change in the laws would place great pioneer research works on a sound financial basis. A Government grant, except for very special purposes, seems to be out of the question, seeing that the benefits to be derived are generally not confined to any one country. An extension of the life of patents, which is now from fourteen to sixteen years in different countries, would be undoubtedly a step in the right direction. It would be of great benefit generally if some scale of duration of patents could be fixed internationally, the scale being fixed according to the subject-matter, the difficulty of the attack, and the past history of the subject, but more especially in view of the utility of the invention.

One of the chief objections raised by the Privy Council against the extension of patents in this country has rightly been that undue prolongation is unfair to the British public, seeing that abroad no prolongations are granted. Therefore, if the duration of patents for important matters is to be extended at home it must also be extended abroad. In other words, such prolongations, to be effective, should necessarily extend to other countries. They should be international, and concurrent in all the countries interested.

One possible solution of this difficult question would be to place such matters under the jurisdiction of a Central International Committee, who would have the apportionment of the life and privileges of patents and of the extension or curtailment of their duration, according to their handling by the owners. I would ask, Why has a patent a life of only fourteen to sixteen years, while copyright is for forty-two years? Why has a pioneer company making a railway under Act of Parliament generally rights for ever unless it abuses its privileges, or the requirements of the district necessitate the construction of competing lines, while a patent has in comparison a life of infinite shortness?

I might also cite gas companies, electrical supply companies, under Act of Parliament, or provisional orders of forty-two years' duration; and this reminds us of the fact that until the term of life for electric supply companies had been extended from twenty-one years to forty-two years by the bill of 1884, it was impossible to find capital for such undertakings.

Now, it may be urged that the grant of a patent is a different thing from the grant of power to a railway company, a gas or electric supply company. But the object of this Address has been to show that a patent, to be fair to the patentee, ought in many cases to be analogous to an Act of Parliament or a provisional order. Would it not place matters in a fairer position, especially in the case of expensive and lengthy researches, to grant to those who pledge themselves to spend a suitable and minimum sum within a stated period on the research a reasonable and fair monopoly, so that such person or syndicate might in the event of success be in the position to reap a reasonable return for their expenditure and risk?

Some such measure would unquestionably give an immense stimulus to research and invention by enabling capital to be raised and works started on commercial lines in fields of great promise at present almost untouched.

I pass over the disadvantages to the British inventor of the hostile patent tariffs of Continental nations and of the protective patent laws of some of the British dependencies, disadvantages greater than those imposed by protective tariffs on the ordinary British manufacturer.

There is, however, another aspect of the question to which I would briefly allude: it is the great benefits that the world at large has derived from the work of inventors in the past.

Think of the multitude and power of the great steam-engines and gas-engines that drive our factories, and pump the water out of our mines, and supply our cities with water, light, and power; of the great steamships scattered over the ocean and the locomotives on the railways.

Think of the billions of tons of steel that have been made by the Bessemer, Siemens-Martin, and Thomas Gilchrist processes, and of the great superiority and less cost of the material over the puddled iron which it superseded.

Think of the vast work performed by the electric telegraphs and telephones; and we must not fail to include the great chemical and metallurgical processes carried on all over the world, besides the countless other inventions and labour-saving appliances.

Can we form any idea of the commercial value of all these gigantic tools that past inventors have left as a heritage to the human race, and can we venture to place any order of magnitude on so vast a sum?

If we take as our unit of value the whole of the money spent on all inventions, both successful and unsuccessful, I think we shall be much below the mark if we assume that the value of the benefits has on the average exceeded by ten-thousandfold the money spent on making and introducing the inventions.

If this is so, let us see what it means. It means that for every unit of capital spent by the inventors and their friends on invention they have in some cases received nothing back. In some cases they have just got their capital back, in some cases two or threefold, occasionally tenfold, very rarely a hundredfold. Whereas the world at large has received a present of ten-thousandfold greater value than all the money spent and misspent by the small band of past inventors.

In conclusion, let us hope that the inventor will in the future receive more encouragement and support, that the patent laws will be further modified and extended, that the people at large will consider these matters more closely and recognise that they are of first importance to their progress and welfare, and that in the future it may be easier, nay in some cases possible, to carry on many great researches into the secrets of Nature.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY HENRY BALFOUR, M.A., PRESIDENT OF THE SECTION.

IT has frequently been remarked, and not without some justification, that Anthropology is an exceedingly diffuse science, and that it lacks the compactness and relatively well-defined field of enterprise enjoyed by most other sciences. This characteristic has even been employed by many as an argument against regarding Anthropology as a subject of any considerable value for educational purposes, the suggested lack of cohesion being thought to militate against

this science ever being allowed to occupy a similar position in the educational curricula and examination systems of this country as that to which the older sciences have for the most part been admitted. For my own part, I cannot but consider the validity of this argument as open to question. The term Anthropology, used in its unrestricted and, as I venture to think, proper sense, does, I readily admit, embrace a vast and varied field, and it inevitably overlaps, and even wanders far and at times freely into the domains of, other sciences. How should it and how can it be otherwise? We, surely, would be guilty of grievously undervaluing and paying scant respect to our genus were we to imagine that the science devoted to its comprehensive study could be otherwise than far-reaching—call it diffuse if you will—and that it could be expected to avoid driving its roots deeply into other sciences the chief practical interest of which lies, after all, in their adaptability to the service of Man.

In admitting the partial justice of the accusation as regards diffuseness, Anthropology, it seems to me, is really pleading guilty to the possession of an educational quality of which it may rather boast than feel ashamed. A science which is so far-reaching, and yet the nucleus or focussing point of which is so well defined, seems of itself to furnish the materials in great part for a liberal education, if properly handled, and to lend itself to the preparation of the inevitable syllabuses, adapted to the different grades both of general education and of higher scholarship.

I readily admit that the *word* Anthropology is unfortunately cumbersome; but it would seem to be inevitable, since no one has yet provided the science with a compact general name which may serve as an efficient substitute; and, since we must retain it, we may at least expect the word to work for its polysyllabic existence, by covering a wide area and serving as the most general term denoting the study of Man in a wide and all-embracing sense.

It is not my purpose to discuss here the educational value of Anthropology, but frankly and even gladly to admit that Anthropology, in spite of its late recognition as a distinct science worthy of encouragement, has in recent years progressed with rapid strides, and has already reached a stage of developmental progress at which it is necessary to differentiate the several branches of study which are included under the general science, and to adopt a classification which is ever becoming more complex as the various divisions become unwieldy and require subdividing. An extensive terminology has been growing up for the purpose of assigning appropriate names to the already fairly numerous divisions of the main subject. Anthropology is passing through the developmental stages which have been followed by the older sciences, and is merely following normal routine in advancing from the simple to the complex. With the increase of knowledge the elements which together constitute a given science necessarily develop individually as well as collectively, and the original science loses its primitive unity by becoming an ever-increasing aggregation of sub-sciences. This process of subdivision or branching is inseparable from the life-history of an active and progressive science.

The genesis, growth, and maturity of Section H reflects to some extent the development of the study of Anthropology. If we look back nearly sixty years, to a meeting of the Association held in Cambridge in 1845, we see that Ethnology was not mentioned at all in the programme and list of Sections, though one ethnological paper does certainly figure amongst those of the Zoological-Botanical group. We may, however, assume that at this meeting a start was made, and give to Cambridge due credit for having a distinct claim to the parentage of Section H. For, in the following year, 1846, we find in the list of Sections a definite *sub-Section* of Ethnology. Indeed, were we in doubt as to the parentage of the infant sub-Section, there is circumstantial evidence clearly indicating this ancient University city, in the subtle influence apparently exercised upon the mind of the parent by overpowering leanings towards applied mathematics, as manifested by the interesting and otherwise unaccountable fact that the "sub-Section of Ethnology" was in that year humbly parasitic upon Section G, which was then, as now, devoted to "Mechanics"!

From 1847 to 1850 the Ethnological sub-Section came under Section D (Zoology, Botany, and Physiology). In 1851 Ethnology appears in conjunction, and, apparently, on nearly equal terms, with Geography; and so it remained in the year 1862, when the Association again had the privilege of meeting in Cambridge, that profound and ingenious student of Man, Mr. Francis Galton, being president of the dual Section. The Geographico-Ethnological combination lasted until 1868, after which, and until 1880, we find the prospective Section H replaced under the charge of Section D—Biology (which included Zoology, Botany, Anatomy, and Physiology).

The steadily growing vitality of the study of Man is very evident through all these years, from the list of papers read, and one may gather, from the way in which the sub-Section was transferred from Section to Section, that the infant was rapidly outgrowing its nurses, and becoming a troublesome handful. Typographical signs of adolescence, coupled with a yearning for independence, appear in 1883, when, glancing at the list of Sections, we see that, although Anthropology is still a "Department of Biology," not only is it the only "department" specially announced under Section D, but the heading is printed in type of the same magnitude as that used for the Section itself. The printer proved to be a good prophet; for in the following year, 1884, at the meeting in Montreal, the inevitable occurred, and Anthropology blossomed out into the adult stage, and received the emancipation afforded by the assignment of an entire Section to itself, the "Section H," which has, I venture to think, thoroughly justified its existence ever since.

It may be doubted whether we have as yet reached the limit of expansion. The time is likely to come when Section H will be the parent of one or more vigorous sub-Sections, which, again, may repeat the developmental sequence, reaching at length maturity and discretion, and being perhaps allowed to set up for themselves as semi-independent Sections. The original title of a Section of the British Association may disappear entirely as such, after the sub-Sections comprised under it have received their full emancipation. This has happened in the case of Biology, which for some thirty years gave its name to Section D, but which finally gave way before the growth of its enterprising and very progressive offshoots (Zoology, Anthropology, Physiology, and Botany), which one after the other developed into independent Sections. With this segregation of the various component elements of Biology, the old generalised title ceased to appear on the list of the British Association. This, perhaps, will be the fate of the term "Anthropology," as the growth of the subjects which have developed under the wing of this very comprehensive science gradually causes, for the sake of practical convenience, a number of subordinate titles to replace the time-honoured and inclusive term. Should it thus happen, in response to the growth of the science, that this term is destined to follow the far wider term "Biology" into a position of dignified ease, we shall be wise to bear continually in mind that Anthropology is the main stem from which the various branches have sprung, and to the nourishment and growth of which it should be the principal aim of their individual activities to contribute. In an age of ever-increasing specialisation we may from time to time require a reminder of the fact that the true value of researches in the special fields of a science must be estimated by the degree to which their relationship to the whole can be and is rendered manifest. The work of specialists will necessarily lose half its value if there is a dearth of generalists who will gather together the threads and weave them into a substantial fabric, which shall show the importance of each individual piece of work to the progress of the science as a whole.

Once Anthropology became recognised as a definite science, and one worthy of encouragement, the number of its devotees increased steadily and apace, and the range of its work widened rapidly. Indeed, it would appear as though there were an almost feverish desire to make up for time lost through the phenomenal tardiness of the discovery of a seemingly obvious fact, which is that "Man" is in very truth a "proper study for mankind." Energy is not wanting, though this feverishness is kept in rigid subjection by the chilling and reducing effect of starvation for want of funds. The lack of adequate financial support is painfully apparent in Great Britain when we compare the

conditions prevailing here with those obtaining in other countries.

I will not endeavour to cope with the many and varied aspects of Anthropology and its complex ramifications, nor will I attempt to enumerate the many distinguished men of science to whose stimulating work we chiefly owe the progress already achieved in Anthropology; the more prominent pioneers are well known to you, and several, I am glad to say, are yet with us. Their works remain as important landmarks in the developmental record of the Science of Man. I have, instead, selected as my principal theme one branch of the subject. My main object is to review, necessarily briefly, *one* of the factors which have played a part in stimulating scientific inquiry into the past and present conditions of Man, and in furthering the development both of the scientific and the popular interests of Anthropology. I wish to confine myself to the consideration of the contribution of one man towards the subject, a contribution which is the more valuable since it deals with wide principles, and thus affords a basis upon which a vast army of students may found valuable work. It amounted to the establishment of a particular school of research into the history of human culture, into which fresh workers are constantly being attracted, and which has stood the test of time through half a century.

It was about the middle of last century that an officer in Her Majesty's Army began to apply the lessons which he had learnt in the course of some of his professional experimental work to studies pursued by him as a hobby in a far wider field of science. The story of the famous ethnographical collection of Colonel Lane Fox is well known, and I need but briefly refer to it. During his investigations, conducted with a view to ascertaining the best methods whereby the service firearms might be improved, at a time when the old Tower musket was being finally discarded, he was forcibly struck by the extremely gradual changes whereby improvements were effected. He observed that every noteworthy advancement in the efficiency, not only of the whole weapon but also of every individual detail in its structure, was arrived at as a cumulative result of a succession of very slight modifications, each of which was but a trifling improvement upon the one immediately preceding it. Through noticing the unfailing regularity of this process of gradual *evolution* in the case of firearms, he was led to believe that the same principles must probably govern the development of the other arts, appliances, and ideas of mankind. With characteristic energy and scientific zeal Colonel Lane Fox began at once, in the year 1851, to illustrate his views and to put them to a practical test. He forthwith commenced to make the ethnological collection with which his name will always be associated, and which rapidly grew to large proportions under his keen search for material which should illustrate and perhaps prove his theory of progress by evolution in the arts of mankind.

Although as a collector he was somewhat omnivorous, since every artefact product fell strictly within his range of inquiry, his collection, nevertheless, differed from the greater number of private ethnological collections, and even public ones of that day, inasmuch as it was built up *systematically* with a definite object in view. It is unnecessary for me to describe in detail the system which he adopted in arranging his collection. His principles are well known to ethnologists, either from the collection itself or from his writings, more especially from the series of lectures which he gave at the Royal United Service Institution, in the years 1867–69, upon "Primitive Warfare"; from his paper read before the Anthropological Institute in 1874 on "The Principles of Classification," as adopted in the arrangement of his anthropological collection, which was then exhibited at the Bethnal Green Museum; from that portion of the *catalogue raisonné* of his collection which was published in 1877; and from numerous other papers dealing with special illustrations of his theory. Suffice it to say that, in classifying his ethnological material, he adopted a *principal* system of groups into which objects of like form or function from all over the world were associated to form series, each of which illustrated as completely as possible the varieties under which a given art, industry, or appliance occurred. Within these main groups objects belonging to the same region were usually associated together in *local* sub-groups. And wherever amongst the implements or other objects exhibited in a given series there seemed to be suggested a *sequence of ideas*, shedding light upon the probable stages in the evolution of this particular class, these objects were specially brought into juxtaposition. This special grouping to illustrate sequence was particularly applied to objects from the same region as being, from their local relationships, calculated better to illustrate an actual continuity. As far as possible the seemingly more primitive and generalised forms—those simple types which usually approach most nearly to *natural* forms, or the use of which is associated with primitive ideas—were placed at the beginning of each series, and the more complex and specialised forms were arranged towards the end.

The primary object of this method of classification by series was to demonstrate, either actually or hypothetically, the origin, development, and continuity of the material arts, and to illustrate the variations whereby the more complex and specialised forms belonging to the higher conditions of culture have been evolved by successive slight improvements from the simple, rudimentary, and generalised forms of a primitive culture.

The *earlier* stages in these sequence series were more especially the object of investigation, the later developments being in the greater number of cases omitted or merely suggested. It was necessary for Colonel Lane Fox to restrict the extent of the series, any one of which, if developed to the full extent, would easily have filled a good-sized museum. The earlier stages, moreover, were less familiar, and presented fewer complications. The general principles of his theory were as adequately demonstrated by the ruder appliances of uncivilised races as by the more elaborate products of peoples of higher culture; and, moreover, there was doubtless a great attraction in attacking that end of the development series which offered a prospect at least of finality, inasmuch as there was always a chance of discovering the absolute origin of a given series. Hence the major part of his collection consisted in specimens procured from savage and barbaric races, amongst whom the more rudimentary forms of appliances are for the most part to be found.

The validity of the general views of Colonel Lane Fox as to evolution in the material arts of Man was rapidly accepted by a large number of ethnologists and others, who were convinced by the arguments offered and the very striking evidence displayed in their support. I have heard people object to the use of the term "evolution" in connection with the development of human arts. To me the word appears to be eminently appropriate, and I think it would be exceedingly difficult to find one which better expresses the succession of extremely minute variations by means of which progress has been effected. That the successive individual units of improvement, which when linked together form the chain of advancement, *are* exceedingly small is a fact which anyone can prove for himself if he will study *in detail* the growth of a modern so-called "invention." One reason why we are apt to overlook the greater number of stages in the growth of still living arts is that we are not as a rule privileged to watch behind the scenes. Of the numberless slight modifications, each but a trifling advance upon the last, it is but comparatively few which ever meet the eye of the public, which only sees the more important stages; those, that is to say, which present a sufficiently distinct advance upon that which has hitherto been in use to warrant their attracting attention, or, shall we say, having for a time a marketable value. The bulk of the links in the evolutionary chain disappear almost as soon as they are made, and are known to few, perhaps none, besides their inventors. Even where the history of some invention is recorded with the utmost care it is only the more prominent landmarks which receive notice; the multitude of trifling variations which have led up to them are not referred to, for, even if they be known, space forbids such elaborately detailed record. The smaller variations are, for the most part, utterly forgotten, their ephemeral existence and their slight individual influence upon the general progress being unrecorded at the time, and lost sight of almost at once. The immediately succeeding stage claims for the moment the attention, and it again in its turn becomes the stepping-stone upon which the next raises itself, and so on.

Before proceeding further, let me give as briefly as I can an example of a development series worked out, in the main,

upon the general line of inquiry inaugurated by Colonel Lane Fox. It is commonly accepted as a fact, which is borne out by tradition, both ancient and modern, that certain groups of stringed instruments of music must be referred for their origin to the bow of the archer. The actual historical record does not help us to come to a definite conclusion on this point, nor does the direct testimony of archæology, but from other sources very suggestive evidence is forthcoming. A comparative study of the musical instruments of modern savage and barbaric peoples makes it very clear to one that the greater portion of the probable chain of sequences which led from the simple bows to highly specialised instruments of the harp family may be reconstructed from types still existing in use among living peoples, most of the well-defined early stages being represented in Africa at the present day.[1] The native of Damaraland, who possesses no stringed instrument proper, is in the habit of temporarily converting his ordinary shooting-bow into a musical instrument. For this purpose he ties a small thong loopwise round the bow and bow-string, so as to divide the latter into two vibrating parts of unequal length. When lightly struck with a small stick the tense string emits a couple of notes, which satisfy this primitive musician's humble cravings for purely rhythmic sound. Amongst many other African tribes we find a slight advance, in the form of special rather slightly made bows constructed and used for musical purposes only. In order to increase the volume of sound, it is frequently the custom amongst some of the tribes to rest the bow against some hollow, resonant body, such as an inverted pot or hollow gourd. In many parts, again, we find that the instrument has been further improved by *attaching* a gourd to the bow, and thus providing it with a permanent resonating body. To achieve greater musical results, it would appear that somewhere in Africa (in the West, I suspect) two or more small bows were attached to a single gourd. I have, so far, been unable to trace this particular link in Africa itself, but, curiously enough, this very form has been obtained from Guiana. It may be thought that I am applying a breaking strain to the chain of evidence when I endeavour to work an instrument from South America into an African developmental series. But, when we recall the fact that evidence of the existence of *indigenous* stringed instruments of music in the New World has yet to be produced, coupled with the certain knowledge that a considerable number of varieties of musical instruments, stringed and otherwise, accompanied the enforced migration of African natives during the days of the slave trade, and were thus established in use and perpetuated in many parts of the New World, including the north-east regions of South America, we may, I think, admit with some confidence that in this particular instance from Guiana to Guinea is no very far cry, and that the more than probable African origin of this instrument from South America gives it a perfect claim to take its place in the African sequence. I still anticipate that this type of instrument will be forthcoming from some hinterland region in West Africa. Were *no* evidence at all forthcoming of such a form, either in past or present, we should be almost compelled to infer that such a one had existed, as this stage in the sequence appears to be necessary to prevent a break in the continuity of forms leading to what is apparently the next important stage, represented by a type of instrument common in West Africa, having five little bows, each carrying its string, and all of which are fixed by their lower ends into a box-like wooden resonator. This method of attaching the bows to the now improved body of the instrument necessitates the lower attachment of the strings being transferred from the bows to the body, so that the bow-like form begins to disappear. The next improvement of which there is evidence from existing types consists in the substitution of a single, stouter, curved rod for the five little "bows," all the five strings being serially attached to the upper end of the rod, their lower ends to the body as before. This instrument is somewhat rare now, and it may well be a source of wonder to us that it has survived at all (unless it be to assist the ethnologist), since it is an almost aggressively inefficient form, owing to the row of strings being brought into two different planes at right angles to one another. The structure of this rude instrument gives it a quaintly composite appearance, suggesting that it is a banjo at one end and a harp at the other. This is due to the strings remaining, as in the preceding form, attached to the resonating body in a line disposed *transversely*, while the substitution of a single rod for the five "bows" has necessitated the disposal of their upper attachments in a *longitudinal* series as regards the longer axis of the instrument. Inefficient though it be, this instrument occupies an important position in the apparent chain of evolution, leading on as it does through some intermediate types to a form in which the difficulty as regards the strings is overcome by attaching their *lower* ends in a longitudinal series, and so bringing them into the same plane throughout their length. In this shape the instrument has assumed a harp-like form—a rude and not very effective one, it is true, but it is none the less definitely a member of the harp family. The modern varieties of this type extend across Africa from west to east, and the harps of ancient Egypt, Assyria, Greece, and India were assuredly elaborations of this primitive form. The Indian form, closely resembling that of ancient Egypt, still survives in Burma, while elsewhere we find a few apparently allied forms. In all these forms of the harp, from the rudest Central and West African types to the highly ornate and many-stringed examples of Egypt and the East, one point is especially noteworthy. This is the invariable *absence of the fore-pillar*, which in the modern harps of Western Europe is so important, nay, essential, a structural feature. In spite of the skill and care exercised in the construction of some of the more elaborate forms, none were fitted with a fore-pillar, the result being that the frame across which the strings were stretched was always weak and disposed to yield more or less to the strain caused by the tension of the strings. This implied that, even when the strings were not unduly strained, the tightening up of one of them to raise its pitch necessarily caused a greater or less slackening of all the other strings, since the free end of the rod or "neck" would tend to be drawn slightly towards the body of the instrument under the increased tension. One can picture the soul-destroying agonies endured by two performers upon these harps when endeavouring, if they ever did so, to bring their refractory instruments into unison, while, as for the orchestral music of the old Assyrian days—well, perhaps we had better not attempt to picture *that!* The mere addition of a simple, strut-like support between the free end of the "neck" and the "body" would have obviated this difficulty and rendered the instrument relatively efficient and unyielding to varying tension. And yet, even in Western Europe, this seemingly obvious and invaluable addition did not appear, as far as I can ascertain, until about the seventh or eighth century A.D.; and even then it seems to have been added somewhat half-heartedly, and a very long time had yet to elapse before the fore-pillar became an integral part of the framework and was allotted its due proportion in the general design.

I have purposely selected this particular series for my illustration, not because it is something new—indeed, it is already more or less familiar, and maybe has even some merit in its lack of newness, since, in accordance with a popular dictum, it may urge a greater claim to be regarded as true—nor because it is specially striking, but rather for the reason that it illustrates suitably several of the points upon which I wish briefly to touch. Even in the severely condensed form in which I have been obliged to present this series of developments from bow to harp, there is, I think, demonstrated the practical application of several of the general principles upon which is based the theory whereby Colonel Lane Fox sought to elucidate the phenomena of human progress.

A series of this kind serves, in the first place, to demonstrate that the absence of historical and archæological evidence of the *actual* continuity in development from simple to complex does not preclude investigations into the early history of any product of human ingenuity, nor prevent the formation of a suggestive and plausible if largely hypothetical series, illustrating the probable chain of sequences along which some highly specialised form may be traced back link by link to its rudimentary prototypes, or even to its absolute origin, which in this particular instance is the ordinary shooting bow *temporarily* converted into a musical instrument. Where an actual chronological series is not forthcoming, a comparative study of such types as are

[1] "The Natural History of the Musical Bow." By H. Balfour. Clarendon Press, Oxford.)

available, even though they be *modern* examples, reveals the fact that, if classified according to their apparent morphological affinities, these types show a tendency to fall into line, the gap between the extreme forms—that is, the most simple and the most advanced—being filled by a succession of intermediate forms, more or less completely linked together, according to the number of varieties at our disposal. We are thus, at any rate, in possession of *a* sequence series. Is it unreasonable for us to conclude that this reflects, in great measure, *the* actual chronological sequence of variations through which in past times the evolutionary history of the instrument was effected from the earliest rudimentary form?

It is difficult to account at all for the existence of many of the forms such as I have briefly described, except on the supposition that they are *survivals* from more or less *early stages* in a series of progressive evolution; and, for myself, I do not believe that so inefficient and yet so elaborate an instrument as, to take an example, the harp of ancient Egypt, Assyria, and India could have come into being by any sudden inventive process, by "spontaneous generation," as it were, to use a biological term; whereas, the innate conservatism of the human species, which is most manifest among the lower and more primitive races (I use the term conservatism, I need hardly say, in a non-political sense) amply accounts for such forms having been arrived at, since the rigid adherence to traditional types is a prevailing characteristic of human culture, and only admits of improvement by very slight and gradual variations upon existing forms. The difficulty experienced by man in a primitive condition of culture of emancipating himself from the ideas which have been handed down to him, except by a very gradual and lengthy process, causes him to exert somewhat blindly his efforts in the direction of progress, and often prevents his seeing very obvious improvements, even when they are seemingly forced upon his notice. For instance, the early Egyptian, Assyrian, and Greek harps, as I have already stated, were destitute of a fore-pillar, and this remained the case for centuries, in spite of their actually existing in an environment of other instruments, such as the lyre and *trigonon*, which in their rigid, unyielding frames possessed and even paraded the very feature which was so essential to the harp, to enable it to become a really efficient instrument. The same juxtaposition of similar types, without mutual influence, may be seen in modern Africa among ruder forms of these instruments.

And yet, in spite of instances such as this—where a valuable feature suggested by one instrument has not been adopted for the improvement of another, even though the two forms are in constant use side by side—we must recognise that progress in the main is effected by a process of bringing the experience gained in one direction to bear upon the results arrived at in another. This process of grafting one idea upon another, or, as we may call it, the hybridisation of ideas and experience, is a factor in the advancement of culture the influence of which cannot be overestimated. It is, in fact, the main secret of progress. In the animal world hybridisation is liable to produce *sterile* offspring; in the world of ideas its results are usually far different. A fresh stimulus is imparted, which may last through generations of fruitful descendants. The *rate* at which progress is effected increases steadily with the growth of experience, whereby the number of ideas which may act and react upon one another is augmented.

It follows, as a corollary, that he who would trace out the phylogenetic history of any product of human industry will speedily discover that, if he aims at doing so *in detail*, he must be prepared for disappointments. The tangle is too involved to be completely unravelled. The sequence, strictly speaking, is not in the form of a simple chain, but rather in that of a highly complex *system* of chains. The time-honoured simile afforded by a river perhaps supplies the truest comparison. The course of the *main stream* of our evolution series may be fairly clear to us, even as far as to its principal source; we may even explore and study the general effect produced by the more important tributaries; but to investigate in detail the contributions afforded in present and past of the innumerable smaller streams, brooks, and runlets is clearly beyond anyone's power, even supposing that the greater number had not changed their course at times, and even, in many cases, run dry. While we readily admit that important effects have been produced by these numberless tributary influences, both on the course and on the volume of the river, it is clear that we must in general be content to follow the main stream. A careful study of the series of musical instruments, of which I gave but a scanty outline, reveals very clearly that numberless ideas borrowed from outside sources have been requisitioned and have affected the course of development. In some cases one can see fairly clearly whence these ideas were derived, and even trace back in part their own phylogenetic history; but a complete analysis must of necessity remain beyond our powers and even our hopes.

It will have been observed that, in the example of a sequence series which I have given, the early developmental stages are illustrated entirely by instruments belonging to *modern savage races*. It was a fundamental principle in the general theory of Colonel Lane Fox that in the arts and customs of the still living savage and barbaric peoples there are reflected to a considerable extent the various strata of human culture in the past, and that it is possible to reconstruct in some degree the life and industries of Man in prehistoric times by a study of existing races in corresponding stages of civilisation. His insistence upon the importance of bringing together and comparing the archæological and ethnological material, in order that each might serve to throw light upon the other, has proved of value to both sciences. Himself a brilliant and far-seeing archæologist as well as ethnologist, he was eminently capable of forming a conclusion upon this point, and he urged this view very strongly.

The earth, as we know, is peopled with races of the most heterogeneous description, races in all stages of culture. Colonel Lane Fox argued that, making due allowance for possible instances of degradation from a higher condition, this heterogeneity could readily be explained by assuming that, while the progress of some races has received relatively little check, the culture development of other races has been retarded to a greater or less extent, and that we may see represented conditions of at least partially arrested development. In other words, he considered that in the various manifestations of culture among the less civilised peoples were to be seen more or less direct *survivals* from the earlier stages or strata of human evolution; vestiges of ancient conditions which have fallen out at different points and have been left behind in the general march of progress.

Taken together, the various living races of Man seem almost to form a kind of living genealogical tree, as it were, and it is as an epiphyte upon this tree that the comparative ethnologist largely thrives; while to the archæologist it may also prove a tree of knowledge the fruit of which may be eaten with benefit rather than risk.

This certainly seems to be a legitimate assumption in a general way; but there are numerous factors which should be borne in mind when we endeavour to elucidate the past by means of the present. If the various gradations of culture exhibited by the condition of living races—the savage, semi-civilised, or barbaric, and the civilised races—could be regarded as accurately typifying the successive stages through which the higher forms of culture have been evolved in the course of the ages; if, in fact, the different modern races of mankind might be accepted as so many sections of the human race the intellectual development of which has been arrested or retarded at various definite stages in the general progression, then we should have, to all intents and purposes, our genealogical tree in a very perfect state, and by its means we could reconstruct the past and study with ease the steady growth of culture and handicrafts from the earliest simple germs, reflecting the mental condition of primæval man up to the highest manifestations of the most cultured races.

These ideal conditions are, however, far from being realised. Intellectual progress has not advanced along a single line, but, in its development, it has branched off in various directions, in accordance with varying environment; and the tracing of lines of connection between different forms of culture, as is the case with the physical variations, is a matter of intricate complexity. Migrations with the attendant climatic changes, change of food, and, in fact, of general environment, to say nothing of the crossing of different stocks, transmission of ideas from one people to another, and other factors, all tend to increase the tangle.

Although in certain instances savage tribes or races show obvious signs of having *degenerated* to some extent from conditions of a higher culturedom, this cannot be regarded as the general rule, and we must always bear in mind the seemingly paradoxical truth that degradation in the culture of the lower races is often, if not usually, the direct result of contact with peoples in a far higher state of civilisation.

There can, I think, be little doubt that Colonel Lane Fox was well justified in urging the view that most savage races are in large measure strictly *primitive*, survivals from early conditions, the development of their ideas having from various causes remained practically stationary during a very considerable period of time. In the lower, though not degenerate, races signs of this are not wanting, and while few, possibly none, can be said to be absolutely in a condition of arrested development, their normal progress is at a slow, in most cases at a *very* slow, rate.

Perhaps the best example of a truly primitive race existing in recent times, of which we have any knowledge, was afforded by the native inhabitants of Tasmania. This race was still existing fifty years ago, and a few pure-blooded survivors remained as late as about the year 1870, when the race became extinct, the benign civilising influence of enlightened Europeans having wiped this extremely interesting people off the face of the earth. The Australians, whom Colonel Lane Fox referred to as being "the lowest amongst the existing races of the world of whom we have any accurate knowledge," are very far in advance of the Tasmanians, whose lowly state of culture conformed thoroughly with the characteristics of a truly primitive race, a survival not only from the Stone Age in general, but from almost the earliest beginnings of the Stone Age. The difference between the culture of the Tasmanians and that of the Australians was far greater than that which exists between man of the "River Drift" period and his Neolithic successors. The objects of every-day use were but slight modifications of forms suggested by Nature, involving the exercise of merely the simplest mental processes. The stone implements were of the rudest manufacture, far inferior in workmanship to those made by Palæolithic man; they were never ground or polished, never even fitted with handles, but were merely grasped in the hand. The *varieties* of implements were very *few in number*, each, no doubt, serving a number of purposes, the function varying with the requirements of the moment. They had no bows or other appliances for accelerating the flight of missiles, no pottery, no permanent dwellings; nor is there any evidence of a previous knowledge of such products of higher culture. They seem to represent a race which was isolated very early from contact with higher races; in fact, before they had developed more than the merest rudiments of culture—a race continuing to live under the most primitive conditions, from which they were never destined to emerge.

Between the Tasmanians, representing in their very low culture the one extreme, and the most civilised peoples at the other extreme, lie races exhibiting in a general way intermediate conditions of advancement or retardation. If we are justified, as I think we are, in regarding the various grades of culture observable among the more lowly of the still existing races of man as representing to a considerable extent those vanished cultures which in their succession formed the different stages by which civilisation emerged gradually from a low state, it surely becomes a very important duty for us to study with energy these living illustrations of early human history in order that the archæological record may be supplemented and rendered more complete. The material for this study is vanishing so fast with the spread of civilisation that opportunities lost now will never be regained, and already even it is practically impossible to find native tribes which are wholly uncontaminated with the products, good or bad, of higher cultures.

The arts of living races help to elucidate what is obscure in those of prehistoric times by the process of reasoning from the known to the unknown. It is the work of the zoologist which enables the palæontologist to reconstruct the forms of extinct animals from such fragmentary remains as have been preserved, and it is largely from the results of a comparative study of living forms and their habitats that he is able, in his descriptions, to equip the reconstructed types of a past fauna with environments suited to their structure, and to render more complete the picture of their mode of life.

In like manner, the work of the ethnologist can throw light upon the researches of the archæologist: through it broken sequences may be repaired, at least suggestively, and the interpretation of the true nature and use of objects of antiquity may frequently be rendered more sure. Colonel Lane Fox strongly advocated the application of the reasoning methods of biology to the study of the origin, phylogeny, and etionomics of the arts of mankind, and his own collection demonstrated that the products of human intelligence can conveniently be classified into families, genera, species, and varieties, and *must* be so grouped if their affinities and development are to be investigated.

It must not be supposed—although some people, through misapprehension of his methods, jumped at this erroneous conclusion—that he was unaware of the danger of possibly mistaking mere accidental resemblances for morphological affinities, and that he assumed that *because* two objects, perhaps from widely separated regions, appeared more or less identical in form, and possibly in use, they were necessarily to be considered as members of one phylogenetic group. On the contrary, in the grouping of his specimens according to their form and function, he was anxious to assist as far as possible in throwing light upon the question of the monogenesis or polygenesis of certain arts and appliances, and to discover whether they are exotic or indigenous in the regions in which they are now found, and, in fact, to distinguish between mere analogies and true homologies. If we accept the theory of the monogenesis of the human race, as most of us undoubtedly do, we must be prepared to admit that there prevails a condition of unity in the tendencies of the human mind to respond in a similar manner to similar stimuli. Like conditions beget like results; and thus instances of independent invention of similar objects are liable to arise. For this very reason, however, the arts and customs belonging to even widely separated peoples may, though apparently unrelated, help to elucidate some of the points in each other's history which remain obscure through lack of the evidence required to establish *local* continuity.

I think, moreover, that it will generally be allowed that cases of "independent invention" of similar forms should be considered to have established their claim to be regarded as such only after exhaustive inquiry has been made into the possibilities of the resemblances being due to actual relationship. There is the alternative method of assuming that, because two like objects are widely separated geographically, and because a line of connection is not immediately obvious, therefore the resemblance existing between them is fortuitous, or merely the natural result of similar forms having been produced to meet similar needs. Premature conclusions in matters of this kind, though temptingly easy to form, are not in the true scientific spirit, and act as a check upon careful research, which, by investigating the case in its various possible aspects, is able either to prove or disprove what otherwise would be merely a hasty assumption. The association of similar forms into the same series has therefore a double significance. On the one hand, the sequence of related forms is brought out, and their geographical distribution illustrated, throwing light, not only upon the evolution of types, but also upon the interchange of ideas by transference from one people to another, and even upon the migration of races. On the other hand, instances in which two or more peoples have arrived independently at similar results are brought prominently forward, not merely as interesting coincidences, but also as evidence pointing to the phylogenetic unity of the human species, as exemplified by the tendency of human intelligence to evolve independently identical ideas where the conditions are themselves identical. Polygenesis in his inventions may probably be regarded as testimony in favour of the monogenesis of Man.

I have endeavoured in this Address to dwell upon some of the main principles laid down by Colonel Lane Fox as a result of his special researches in the field of Ethnology, and my object has been twofold. First, to bear witness to the very great importance of his contribution to the scientific study of the arts of mankind and the development of culture in general, and to remind students of Anthropology of the debt which we owe to him, not only for the results of his

very able investigations, but also for the stimulus which he imparted to research in some of the branches of this comprehensive science. Secondly, my object has been to reply to some criticisms offered in regard to points in the system of classification adopted in arranging his ethnographical collection. And, since such criticisms as have reached me have appeared to me to be founded mainly upon misinterpretation of this system, I have thought that I could meet them best by some sort of restatement of the principles involved.

It would be unreasonable to expect that his work should hold good in all details. The early illustrations of his theories were to be regarded as tentative rather than dogmatic, and in later life he recognised that many modifications in matters of detail were rendered necessary by new facts which had since come to light. The crystallisation of solid facts out of a matrix which is necessarily partially volatile is a process requiring time. These minor errors and the fact of our not agreeing with all his details in no way invalidate the general principles which he urged, and we need but cast a cursory glance over recent ethnological literature to see how widely accepted these general principles are, and how they have formed the basis of, and furnished the inspiration for, a vast mass of research by ethnologists of all nations.

It appears more than probable that Cambridge will be much involved in the future advancement of anthropological studies in Great Britain, if we may judge from the evident signs of a growing interest in the science, not the least of which is the recent establishment of a Board of Anthropological Studies, an important development upon which we may well congratulate the University. Within my own experience there have been many proofs of the existence in Cambridge of a keen sympathy with the principles of ethnological inquiry developed by Colonel Lane Fox, and I feel that, as regards my choice of a theme for the main topic of my address, no apology is needed. For my handling of this theme, on the other hand, I fear it must be otherwise. I would gladly have done fuller justice to the work of Colonel Lane Fox, but, while I claim to be among the keenest of his disciples, I must confess to being but an indifferent apostle.

I have been obliged, moreover, to pass over many interesting features in the work of this ingenious and versatile man of science. I have made no attempt to touch upon his archæological researches, since it has been necessary for me to restrict myself to a portion only of his scientific work. In this field, as in his ethnological work, his keen insight, ingenuity, and versatility were manifested, while the close attention which he bestowed upon matters of minute detail has rendered classical his work as a field archæologist. While the greater part of his ethnological work is associated with the name Lane Fox, by which he was known until 1880, most of his researches into the remains of prehistoric times were conducted after he had in that year assumed the name of Pitt Rivers, on inheriting an important estate which, by the happiest of coincidences, included within its boundaries a considerable number of prehistoric sites of the highest importance. That he made full use of his opportunities is amply manifested in his published works. In his archæological work are repeated the characteristics of his ethnological researches, and one may with confidence say of his contributions to both fields of inquiry that, if he advanced science greatly through his results he furthered its progress even more through his methods. By his actual achievements as a researcher he pushed forward the base of operations; by his carefully-thought-out systems for directing research he developed a sound strategical policy upon which to base further organised attacks upon the Unknown.

NOTES.

THE Hugh Miller Memorial Institute at Cromarty was opened on Friday last by Mr. Andrew Carnegie. The institute, which had its inception at the Hugh Miller centenary celebrations two years ago, is a short distance from the house where the geologist was born, and the accommodation provided includes a public library. The site was given by Colonel Ross, of Cromarty; the cost of the building, amounting to 1200*l.*, was defrayed by Mr. Carnegie, and the public subscribed 400*l.* for an endowment fund.

THE director of the Paris Museum of Natural History has been authorised to accept a gift made by M. Durand of a collection of herbaria and a botanical library, a sum of 5000 francs to pay the expense of transporting and installing these collections, and a further sum of 50,000 francs to be invested with a view to provide a fund for the upkeep of the herbaria and the purchase of plants and of works on botany.

THE International Congress of Physiologists was opened at the Solvay Institute in Brussels on Tuesday.

THE fourth congress of the International Aëronauts Committee, convened by the Imperial Academy of Sciences, was opened at St. Petersburg on Monday.

IT is reported that Mr. Henry Phipps has given 4000*l.* to the Johns Hopkins University, for the study of tuberculosis.

IT is announced that the late Mr. John Innes bequeathed the sum of 300,000*l.* for the erection of a museum at Merton, Surrey.

THE committee appointed by the Texas Legislature to investigate methods for the extermination of the boll weevil and pay a reward of 10,000*l.* to the discoverer of any such method, has decided, says *Science*, that no one has earned this reward.

THE Lancashire and Western Sea Fisheries Joint Committee has appointed Dr. J. T. Jenkins, professor of biology in Hartley University College, Southampton, to be superintendent of sea fisheries in place of the late Captain Dawson.

MR. W. I. LAST, senior keeper in the science division of the Victoria and Albert Museum, has been appointed director of that division of the museum in succession to Major-General Festing, C.B., F.R.S., who has recently retired at the age of sixty-four on the operation of the age limit. Mr. Last was senior Whitworth scholar in 1877, and a Watt medallist of the Institution of Civil Engineers in 1887, and has been for the last few years senior keeper in the science division of the museum, with the special charge of the engineering collections.

THE second International Congress on the History of Religions was opened at Basel on Tuesday. Prof. von Orelli, president of the organising committee, read an address, in the course of which he pointed out that the objects of the conference were purely scientific, and that a propaganda in favour of a particular sect and controversies on the lines of religious discussions during the Middle Ages would not be allowed.

WITH the view to obtain further information on the growth and migrations of salmon (including sea-trout, salmon-trout, peal, sewin, &c.), the Board of Agriculture and Fisheries had had a number of such fish "marked" by attaching a small oblong silver label (oxidised, or blackened, and bearing distinctive letters and numbers) to the dorsal or large back fin. Small rewards will be paid for the recovery of fish bearing such labels or other "marks," or for information respecting them. The Board has prepared lists of persons in the south and west of England, in Wales and Monmouthshire, and in the north of England, who will receive marked fish. The experiments will be continued during a series of years, and the cooperation of net-fishermen, anglers, fishmongers, and all interested in the improvement of the salmon fisheries, is invited in order that the fullest possible results may be secured.

THE value and possibilities of wireless telegraphy as a journalistic adjunct are described in Saturday's *Times* by the special correspondent who established a wireless telegraph system at the theatre of war operations in the Far East with such success that both the belligerents regarded the enterprise as dangerous to their interests. The Japanese Government placed such limitations upon the free movements of the *Haimun*—the vessel chartered by the *Times* for its wireless telegraph service—that this means of communication was discontinued of necessity; and there seems little doubt that in future the use of all systems of wireless communication will be controlled by international law. The De Forest system, with its telephonic receiver, was adopted by the *Times* correspondent as most suitable for war messages, as it will allow the operators to record twenty to thirty words a minute, and its usefulness is not impaired by the working of other systems in the vicinity. The land station was at Wei-hai-wei, where a mast 170 feet high was erected. Even with a mast 90 feet high and 102 feet exposure of wire on board the moving ship, there was not the slightest difficulty in keeping up intercommunication at a distance of 100 sea miles. With the 170 feet mast on land, perfect communication was established over a distance of 180 sea miles, and on one occasion over 210 miles. A long message sent from a point 155 miles from the land station had to cross 30 miles of the mountainous corner of the Shan-tung promontory, the hills of which vary from 200 feet to 1860 feet in height, yet the message reached its destination. As soon as the apparatus was in working order, both Russian and Japanese messages were received by the operator, who could easily recognise the difference in the systems employed, and by this means it was possible approximately to tell the distance of the *Haimun* from the various ships. Moreover, the operator began to recognise the notes of various ships, that is to say, he could tell if a Russian ship was at sea by listening for the answering communication from the shore. He could also detect whether the Japanese messages were being transmitted by relay to the naval base or whether the fleet itself was at sea. The information thus obtained guided the movements of the correspondent, and thus assisted the enterprise, which has had to be abandoned on account of the restrictions placed upon it.

IN NATURE of June 2, Dr. H. A. Wilson pointed out (p. 101) that Prof. Rutherford's value for the absorption coefficient of α rays is nearly 2000 times greater than Lenard's value for the absorption coefficient of β rays of the same speed. He suggested, as an explanation, that the α rays consist of positive electrons having a radius 2000 times smaller than negative electrons. Prof. W. H. Bragg, of the University of Adelaide, in a letter which the limitations of space prevent us from publishing, gives reasons for believing that the α rays penetrate further than β rays of the same speed because they do not suffer from deflection by collision, whereas β radiation of this speed is very much affected thereby.

THE results of an attempt to derive formulæ by which the effect of wind and atmospheric pressure on the tides could be calculated were given by Mr. F. L. Ortt in NATURE several years ago (1897, vol. lvi. pp. 80–84). Dr. Wegemann informs us that these formulæ are printed in the *Getijtafels* for 1904, though they are only true for the deep water at the Hook of Holland and Ymuiden. Theoretical considerations have shown that the tables are not applicable to shallow water (Wegemann, *Annalen der Hydrogr.*, 1904, v.). Dr. Wegemann suggests that in deriving a general formula it would be desirable to name the directions of the wind, not according to the compass, but to the angle at which they touch the coast. The places should also be grouped according to depth, coast-line, and formation of the sea floor.

DURING each of the months April to June last, the usual scientific balloon ascents have taken place in the countries which generally participate in these useful experiments. Some of the flights have attained great altitudes, *e.g.* three registering balloons sent up by Baron v. Bassus, from Munich, averaged more than 19,000 metres. Two ascents, from Pavlovsk and from Itteville (near Paris), attained 17,600 metres or more, and one from Trappes reached 16,540 metres. Kite ascents were also made each month by Mr. Rotch at Blue Hill (U.S.), and in May and June by Mr. Dines at Oxshott (Surrey). The value of these researches is recognised by the Royal Academy of Sciences of Amsterdam, which has awarded the Buys-Ballot medal for 1903 to Messrs. R. Assmann, director of the Aëronautical Observatory at Tegel (near Berlin), and A. Berson, of the same institution, for "the great services they have rendered to the development of meteorology" by means of daily observations of the upper air, and as editors of, and contributors to, an elaborate work on scientific balloon ascents.

FROM a report which we have received, it is seen that the present Meteorological Service in Japan is highly organised and more centralised than in this country. It is placed under the direction of the Central Observatory at Tokio, and under the supervision of the Minister of Education, who determines the sites of the provincial stations; any persons who desire to erect meteorological stations (except for rainfall only) must obtain the necessary sanction from the Minister. All provincial stations of the first and second orders have to forward monthly and annual registers to the Central Observatory, while stations of the third order (of which there are more than 1200) send their observations to the "provincial" stations to which they belong. The method of taking observations and the reductions are made in accordance with the regulations of the International Meteorological Committee, and each station is inspected once in three or four years. The principal publications are the daily weather map, monthly and annual reports, and a monthly weather review. The text of the daily weather map is given in English and Japanese. Storm warning telegrams are issued to some 360 stations, and signals are hoisted by day and night. The average success of weather forecasts is 82 per cent., and that of storm warnings 70 per cent. Maritime meteorology has been carried on since 1888; all ships with a tonnage exceeding 100 tons forward logs to the Central Observatory. Much attention is given to earthquake phenomena and to magnetic observations, and since 1880 several expeditions have been made from time to time to high mountains in various portions of the Empire to investigate the processes of the higher strata of the atmosphere. The present director of the service is K. Nakamura.

THE first part of a new serial, *Memoirs of Natural Sciences of the Brooklyn Museum*, is devoted to an account of the medusas of the Bahamas, by Mr. A. G. Mayer. Numerous new forms are described, and the author directs special attention to the difference between the medusa-fauna of the Bahamas and that of the Tortugas—a difference correlated with physical differences in the two areas.

WE have received the July issues of the *Emu* and the *Victorian Naturalist*, the contents of both of which are chiefly devoted to matters of local interest, although a new kestrel from Western Australia is described in the former.

ORNITHOLOGICAL subjects constitute the contents of the August number of the *Zoologist*, so far at least as the separate articles are concerned, the measurements and weights of the eggs of the commoner members of the plover tribe being recorded in the first article by the Messrs. Buchanan. A photograph of the new Orkney vole, in juxtaposition with one of the common vole, forms the frontispiece to the number.

A BICAUDATE specimen of the king-crab is described by Mr. F. F. Smith in No. 8 of *Tuft's College Studies*, while Mr. G. Winslow records three cases of structural abnormalities in tailed amphibians. The origin of the hypophysis cerebri in the salamander, Amblystoma, especially in connection with the dispute as to whether it is an endodermal or ectodermal structure, is discussed at considerable length by Messrs. Kingsley and Thyng, and the histology of the digestive tract of the same creature receives attention at the hands of Mr. G. A. Bates. In a list of the mammals in the Barnum Museum of Tuft's College, by Mr. A. E. Preble, it is somewhat curious to find the African elephant "Jumbo" figuring as *Elephas indicus*; it is sincerely to be hoped that this is an error, and not the result of a discovery that *E. indicus* is the proper title of the African elephant.

IN the *American Journal of Science* for August, Dr. C. R. Eastman discusses the nature of the limb-like appendages in the fish-like creatures collectively known as Osteostraci, as exemplified in the family Asterolepididæ. Five theories have been propounded to explain the nature of these structures. They have been likened, firstly, to arthropod limbs; secondly, they have been regarded as produced and jointed extensions of the head-angles of forms like Cephalaspis; thirdly, they have been derived from a fixed body-spine like that of Acanthaspis; fourthly, they have been considered to be the degenerate development from the lobate fins of the fringe-finned (crossopterygian) ganoids; while, fifthly, they may be *sui generis*. The first two hypotheses Dr. Eastman dismisses as being founded upon misconceptions. The third he regards as presupposing impossible or anomalous conditions. Against the fourth, which was suggested by Mr. C. T. Regan in his paper on the phylogeny of the Teleostomi, recently noticed in our columns, the author advances a number of objections, while he pins his faith on the fifth. Dr. Eastman also takes occasion to record his dissent from Mr. Regan's views as to the existence of a close affinity between the Osteostraci (Cephalaspis, Asterolepis, &c.) and the Arthrodira (Coccosteus); and also as to the alleged relationship between the latter and the fringe-finned ganoids.

IN the same issue Mr. E. H. Sellards publishes an important contribution to our knowledge of Palæozoic cockroaches. Hitherto these insects have been chiefly known by the wings. It is now demonstrated that in bodily organisation they conform essentially to the modern Orthoptera, this agreement also extending to their development, as exemplified by the resemblance of the young to the adult, and by the growth taking place by means of a succession of moults, during which the wings are gradually evolved.

THE fourth volume of the new series of the *Proceedings* of the Aristotelian Society, containing the papers read before the society during the twenty-fifth session, 1903–4, has been published by Messrs. Williams and Norgate. Dr. Shadworth Hodgson contributes two papers dealing respectively with method in philosophy and with reality. Prof. G. F. Stout deals with primary and secondary qualities, and Dr. E. Westermarck has a paper entitled "Remarks on the Subjects of Moral Judgments." Miss E. E. C. Jones recapitulates the main points of Prof. Sidgwick's ethical view, and attempts to answer some of the objections to it that have been brought forward in recent criticisms.

IN vol. xxiv., part iv., of *Notes* from the Leyden Museum, Madame C. M. L. Popta describes as new a number of species of cat-fishes (Siluroids) collected by Dr. Nieuwenhaus in Central Borneo in 1898 and 1900. In the same issue Dr. Jentink records the plantain-bat (*Cerivoula picta*) from Sumatra.

MESSRS. PATTEN AND HART have found that the soluble phosphorus of wheat-bran is organic in nature, existing as the magnesium-calcium-potassium salt of a phospho-organic acid having the formula $C_2H_8P_2O_9$, and probably identical with Posternak's anhydro-oxymethylene diphosphoric acid (*Bull.* No. 250, New York Agricult. Exper. Station). This acid and its salts seem to be of wide distribution in the vegetable kingdom, having already been isolated from peas, beans, pumpkin and lupine seeds, and from the potato and other tubers and bulbs.

IN the July number of the *Gazzetta Chimica Italiana*, a convenient and practical method for the preparation of nitrosyl chloride is described by Francesconi and Bresciani. It is found that carefully prepared animal charcoal exerts a very considerable catalytic influence on the combination of nitric oxide and chlorine, the temperature most favourable for the reaction being 40° to 50° C. Below 35° and above 70° C. the influence of the catalyser is much less marked.

SEVERAL observations are to be found in the literature which indicate that hydrobromic acid at 1000° C. and hydrochloric acid at 2000° C. are perceptibly dissociated into the elements. The direct quantitative measurement of the extent of dissociation at these high temperatures has not yet been found possible. In the *Zeitschrift für physikalische Chemie* (vol. xlix. p. 70), Messrs. Bodenstein and Geiger have, however, calculated the percentage dissociation from known experimental data, the numbers obtained being :—

	1000° abs.	2000° abs
Hydrobromic acid	0·18 per cent.	6·0 per cent.
Hydrochloric acid	0·002 ,,	0·8 ,,

IN the current number (vol. xlix. p. 162) of the *Zeitschrift für physikalische Chemie*, Dr. P. P. Fedotieff gives an account of an investigation of the ammonia-soda process from the standpoint of the phase rule. According to the experimental data, it is theoretically possible to convert 80 per cent. of the sodium chloride used into bicarbonate, and in practice the yield under favourable conditions should not fall below 70 per cent. It is interesting to note that, from a purely chemical standpoint, the Solvay process, in which ammoniacal brine is treated with carbonic acid, is not the best form of the process. The author concludes from his measurements that the treatment of sodium chloride solution with solid ammonium bicarbonate is to be preferred.

AN account of milk investigations at Garforth is given by Dr. C. Crowther in the *Transactions* of the Highland and Agricultural Society of Scotland for 1904. It is found that change from a highly nitrogenous diet to one relatively poor in nitrogen causes secretion of a larger quantity of milk, but the milk is poorer in fat, the change in the fat-content being much more pronounced in the morning than in the evening milk. During the summer months of 1901, 1902, and 1903, the average percentage of fat in the morning milk of the Garforth herd was found on most days to fall below the standard of 3 per cent. embodied in the regulations for the sale of milk at present in force.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER :—

Sept. 2. 11h. 55m. to 12h. 34m. Moon occults σ^2 Tauri (mag. 4·8).
6. Saturn. Major axis of outer ring=42″·96. Minor axis of outer ring=11″·67.
,, 9h. 53m. Minimum of Algol (β Persei).
9. Total eclipse of the Sun, invisible at Greenwich.
15. Venus. Illuminated portion of disc=0·947, of Mars=0·972.
23. Sun enters Libra: autumn commences.
,, 12h. 18m. Neptune's satellite at eastern elongation.
26. 10h. Jupiter in conjunction with Moon. Jupiter 1° 52′ N.
,, 10h. 42m. Neptune's satellite at western elongation.
,, 11h. 36m. Minimum of Algol (β Persei).
29. 8h. 25m. Minimum of Algol (β Persei).
,, 9h. 17m. to 10h. 2m. Moon occults γ Tauri (mag. 3·9).
,, 12h. 33m. to 13h. 8m. Moon occults 71 Tauri (mag. 4·6).
,, 13h. 40m. to 14h. 57m. Moon occults θ^1 Tauri (mag. 3·9).
,, 13h. 50m. to 15h. 0m. Moon occults θ^2 Tauri (mag. 3·6).
,, 18h. 42m. to 19h. 10m. Moon occults α Tauri (mag. 1·1).
30. 11h. 15m. Inferior conjunction of Sat. IV. with Jupiter.

CATALOGUE OF STARS NEAR THE SOUTH POLE.—No. 1, vol. liii., of the Harvard College Observatory *Annals* contains the results obtained during a photographic investigation of the positions of about 200 stars, all of which are situated within half a degree of the South Pole. The positions were measured on negatives enlarged six times from the originals, and nine stars from Gilliss's "Catalogue of 16,478 Southern Stars" were taken as standards.

During the discussion of the results it was found that the values of the residuals exhibited marked gradation, depending on the magnitudes of the stars; the differences were seen to be serious in the final results, and were not eliminated by reversing the plate during the measurements.

A table of magnitude corrections was therefore prepared by graphical methods, and, when applied, reduced the average deviation of the value of the x coordinate from the normal, from $\pm 0''{\cdot}68$ to $\pm 0''{\cdot}36$.

This result was so important that the corrections were also applied to the results given in a similar catalogue for stars near the North Pole, which was published in No. 1, vol. xlviii., of the *Annals*. The resulting corrections are now published in No. 2 of vol. liii.

ANNUAL REPORT OF THE PARIS OBSERVATORY (1903).—The annual report of the Paris Observatory for 1903 was presented to the council by M. Loewy, the director, on March 22.

Among other matters it gives a detailed account of the work accomplished last year in connection with the International Chart and the Eros observations for the re-determination of the solar parallax.

In connection with the former work, thirty-five charts, showing the triple images of some 47,300 stars, have been distributed, and it is hoped that the second volume of the photographic catalogue will be published during the present year.

For the Eros campaign, 10,858 photographic observations of comparison stars and *étoiles de repère*, 284 photographic determinations of the equatorial positions of the planet, and 281 visual micrometric measures, were made during last year.

The seventh part of the "Atlas de la Lune" was published, and the plates show very plainly the marked inferiority of eye observations, as compared with photographs, of our satellite. Several interesting points in selenography, such as the absence of water and the presence of an atmosphere at a remote period, were deducible from the photographs.

The report also gives the details of the large amount of routine work done in the different departments during the past year, and concludes with a bibliography of the published results.

Three important pieces of work, based on novel methods, are to be undertaken in the near future. The first will deal with the determination of latitude and its variations, the second with precise measures of the constant of aberration, and the third with the application of M. Lippman's photographic telescope to meridian observations.

PHOTOGRAPHIC MAGNITUDES AND PLACES OF 350 PLEIADES STARS.—Mr. Dugan publishes the magnitudes and places of 350 stars situated in the Pleiades, which he has obtained from measurements of several plates of the region, in No. 3964 of the *Astronomische Nachrichten*. The star-places are given for 1900, and a chart showing the catalogue number placed against each star image accompanies the paper.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. F. C. WILLCOCKS, demonstrator in entomology and botany at the South-Eastern Agricultural College, Wye, has been appointed entomologist to the Khedivial Agricultural Society at Cairo.

MR. A. LAUDER, assistant lecturer and demonstrator in chemistry at the University College of North Wales, Bangor, has been appointed lecturer in agricultural chemistry at the Edinburgh and East of Scotland College of Agriculture; and Mr. F. E. Rees, assistant lecturer and demonstrator in physics, has been appointed inspector of secondary and technical schools under the Glamorganshire County Council.

IT has been resolved by the Senate of the University of London that the Preliminary Scientific Examination be in future designated the "Preliminary Scientific Examination, Part i.," and the examination in organic chemistry for medical students be designated the "Preliminary Scientific Examination, Part ii." Students are to be permitted to present themselves for Part ii. after an interval of not less than six months from the date of passing Part i. Internal and external students in the Faculty of Medicine who have passed in physics, or chemistry, or botany and zoology, at the final B.Sc. examination will be exempted from examination in the subjects in which they have already passed. Such students, if they have passed in chemistry at the B.Sc. examination, will be excused inorganic chemistry in Part i. and also Part ii. of the Preliminary Scientific Examination. No exemption in biology at the preliminary examination will be granted to students who have not passed in botany and in zoology either at an intermediate examination in science or agriculture, or at the final B.Sc. examination. In future internal and external candidates for Part i. will be required to present themselves for examination either in inorganic chemistry and physics taken together, or in biology, or in all three subjects; but if they fail in any one subject they will be permitted to present themselves for re-examination in that subject taken alone.

MR. FREDERICK SODDY has concluded a series of university extension lectures in Western Australia. The last lecture was delivered on July 23, and on this occasion the Premier of the colony, Mr. Walter James, in proposing a vote of thanks to Mr. Soddy, referred to the desirability of establishing a university in Western Australia. During the course of the last twelve months one distinct step has been taken in advancing the movement by the passage of the University Endowment Act. Endowment trustees have been appointed, and in these trustees some 700 or 800 acres of land have been vested, which promise to give the future university the richest endowment enjoyed by any university in Australia. They were very apt to think, Mr. James continued, that no university could be established unless they first expended a large sum of money in an elaborate building. He wished only they could convince the residents of Western Australia that so long as they had efficient workshops for their professors, the sooner they commenced to get their professors the sooner could they begin the work of the university, without money overburdening it in the first instance. Mr. Soddy's visit has done good in bringing home more thoroughly than before how necessary it is that the establishment of this university should be commenced without undue delay.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal **Society**, July 4.—Prof. Geikie in the chair.—Prof. Cunningham read an obituary notice of the late Prof. His, honorary fellow.—Dr. J. **Halm**, in a note on the structure of the series of line spectra, gave an interesting extension of Balmer's formula for the distribution of lines in a spectrum. Various other formulæ have been given by Rydberg, Kayser and Runge, and others, but none are satisfactory in the sense of being applicable to all substances. Balmer's formulæ for the two hydrogen series may be put in the forms $1/n=am^2$, and $1/n=a(m-\frac{1}{2})^2$, where a is a constant and n is the difference of the oscillation frequencies of the last line of the series and of the mth line in the spectrum. Dr. Halm finds that the series of any other substance can be represented with great accuracy by either of the formulæ $1/n=am^2+b$, $1/n=a(m-\frac{1}{2})^2+b$, where b is a constant characteristic of the particular substance. The whole sets of series for all substances may be represented very concisely by a geometric figure consisting of one set of radiants and a set of transversals each one of which corresponds to the line spectrum of a substance.—Mr. J. R. **Milne** described some of the modifications of his new form of spectrophotometer for measuring the light absorption of dilute solutions. The main feature considered was the use of a Wollaston prism so as to act in the reverse way, that is, to bring together two different rays, instead of separating one ray into two.—The Rev. F. H. **Jackson** communicated a paper giving the complete solution of the differential equation satisfied by his generalised form of Bessel function.

July 18.—Sir John Murray in the chair.—Dr. T. H. **Bryce** read a paper on the histology of the blood of the larva of Lepidosiren (part ii., histogenesis). The paper dealt with the development of the blood corpuscles, and was fully illustrated with lime-light projections. One of the most important results concerned the origin of the leucocytes. They were found arising *in situ*, before the appearance of thymus or spleen, in specialised tracts of the mesenchyme, first in the splanchnic layer and slightly later in the tissue round the nephric tubules.—Mr. J. R. **Milne**, in some notes on experiments in spectrophotometry, gave an account of his method for obtaining what might be called an artificial line spectrum, and so enabling him to use a powerful and steady source of light. In front of the photographic plate an opaque screen with a series of fine transparent slits was set. Only the parts of the continuous spectrum corresponding in position to these slits were photographed on the plate. When a solution of an absorbent substance was introduced, the spectrum photographed was shortened and a fewer number of lines were photographed; but by widening the slit and so increasing the intensity of light it was possible to obtain the original length of spectrum. In this way, in terms of the intensities of light, an estimate of the absorbing power of different solutions could be obtained, probably quite as accurate as by any of the other known methods.—In a note on the magnetic condition of nickel demagnetised by decreasing reversals, Mr. J. **Russell** discussed the production of magnetisation at right angles to a magnetising force which is made to act upon a toroidal tube of nickel after the metal has been demagnetised by reversals. The force was applied at various orientations relatively to the direction of the original magnetisation, which was apparently destroyed by the reversals. Results for iron have already been published, and the results for nickel are similar, though differing considerably in detail. Thus in nickel the transverse induction is much smaller than in iron, being roughly speaking about a twentieth. Also the maximum, which in the case of iron is obtained when the applied field makes an angle of 45° with the original direction of magnetisation, is obtained in the case of nickel at other orientations.—Prof. **Chrystal** read a paper on some particular results in the theory of seiches. The differential equation of free oscillations of a lake of water was found to be capable of a comparatively simple solution when the longitudinal section of the lake was bounded below by a parabola, either concave or convex upwards. The solution was obtained in the form of series which were particular cases of hypergeometric series, but which do not seem to have been discussed. They had properties which were analogous to the properties of sines and cosines, and the functions were accordingly named the seiche-sine, the seiche-cosine, and the hyperbolic seiche-sine and seiche-cosine. In a particular case of special interest in the seiche problem the roots of the cosine and sine are the products 1·2, 3·4, 5·6, &c., and 2·3, 4·5, 6·7, &c., respectively, and this corresponds to the case of the concave parabolic bottom. The roots for the hyperbolic function are not so easily found. They correspond to the case of the convex parabolic bottom, that is, a lake with a shallow in the middle and deeper parts towards the ends. Some promising applications of the investigations have already been made, and it is hoped that when more experimental data are accumulated in regard to the periods of the uni-nodal, bi-nodal, tri-nodal, &c., oscillations, a real explanation of the seiche phenomena will be obtained.

PARIS.

Academy of Sciences, August 22.—M. Mascart in the chair.—The flow of underground water: J. **Boussinesq**. A continuation of preceding papers on the same subject.—On stelliform or ramefied cartilage: Joannes **Chatin**. This type of cartilage has been found in the larynx of a mammal.—Thermoelectric inversion and the neutral point: G. **de Metz**. Previous researches have indicated two simple relations between the temperature of inversion and the neutral point. The author has examined the behaviour of several couples at temperatures down to −185° C., and has found that these equations hold only for the platinum-zinc couple. This couple is therefore valuable for the measurement of low temperatures.—The study and synthetical preparation of some symmetrical cyclic thio-ureas: Emm. **Pozzi-Escot**. The primary amines react with carbon bisulphide in alcoholic solution in presence of caustic potash, with evolution of sulphuretted hydrogen. Details are given of the properties of several of these thio-ureas.—On the freezing point of milk in health and disease: MM. **Giraud** and **Lasserre**. Milk from healthy subjects has a freezing point of −0°·55 to −0°·56. In the case of diseased subjects the freezing point is slightly lower, −0°·58 to −0°·61.

CONTENTS.

THURSDAY, SEPTEMBER 8, 1904.

SOCIAL TYPES AND SOCIAL SELECTION.

Aspects of Social Evolution. First Series. Temperaments. By J. Lionel Tayler, M.R.C.S. Pp. xxviii+297; illustrated. (London: Smith, Elder and Co.) Price 7*s.* 6*d.*

ARE they not methodologically equivalent, the three systems of classification—(*a*) of plants into herbs, shrubs and trees; (*b*) of animals into birds, beasts and fishes; and (*c*) of humans into the sanguine, the lymphatic, the bilious and the melancholy? Why, then, is it that science, having long ago given us a *Systema Naturae* and a *nomenclature botanicus and zoologicus,* still leaves us almost without the rudiments of a *Systema Hominis* and a *nomenclature sociologicus?* It may be asked in reply, What of the anthropologists and their half century of taxonomic labours in the name of science? But the anthropological classifications belong, in appearance at least, to natural and not human history. They do not rise through psychology into sociology. It is true the biologist rejects them, and must continue to do so, as long as the anthropologist cannot formulate his fundamental concept—that of race—in biological terms. Of late the anthropologist has shown signs of attaching himself to the psychologist; and this suggests another form of the initial question, Why have anthropologists not endeavoured to formulate even a provisional classification of psychological types? Why have they, with unconscious naïvete, been content to accept implicitly the popular classification that traditionally survives from early Greek thought? To this question the positivist will be ready with his answer, but perhaps it were wiser to leave it as a shameful reminder to the laggard sociologist.

During the past few years there have appeared, notably in France and in America, a considerable number of systematic studies of psychological types. Dr. Tayler's book is the first systematic endeavour towards taxonomic psychology in this country. Written without reference to foreign sources, it testifies the more convincingly to the presence of a general movement of thought. Though tardily manifesting itself here in systematic form, yet the movement is conspicuously marked by British initiative. By postulating (in "Hereditary Genius," 1869) the variability of psychological type and the correlation of this variability with national history, Francis Galton made a pioneer advance of the first importance in linking psychology with sociology and both with biology. A way was thus opened for several new lines of research, of which some have been considerably developed. Of these two only call for reference here—(*a*) taxonomic studies of character and temperament, alluded to above as being prosecuted mainly by French psychologists like Paulhan, Ribèry and Fouillée, and by American sociologists like Giddings, Patten and Adams; and (*b*) evolutionist studies seeking to decipher selective processes in history and in contemporary civilisation whereby certain types are eliminated and others encouraged. Of these latter investigators, notable examples are Lapouge, Seeck, Ammon, Hansen, &c.

Dr. Tayler's book belongs to both these lines of research, and contributes original material—both observational and speculative—to each. To the more taxonomic side, Dr. Tayler contributes (*a*) studies of several selected types affirmed to be of a highly representative social character; (*b*) the suggestion that the functioning of certain glands (especially the sexual ones) is a main factor in determining temperaments, and hence the idea that from this source are derivable principles of division for a natural classification of temperaments. To the more evolutionist side Dr. Tayler contributes the conceptions of domestic selection and occupational selection as dominant factors in that complex of historical processes which collectively are increasingly described as social selection in contradistinction to natural selection.

The salient feature of the book is the contrast set up between two opposed series of types. The one series is composed of variants on the type generalised by popular observation in the "John Bull" concept. The other series, in contrast to the first, is characterised by (*a*) a more delicate and complex physiological organisation attuned to an increasing complexity of environment; (*b*) a more complete and subtle sexual differentiation, both physical and psychical; (*c*) a relatively greater subordination of carnal to culture interests; and (*d*) readier response to the social ideals created by art, sanctioned by religion, formulated by science. For these two contrasted series of sociological types observable in contemporary western civilisation, Dr. Tayler uses the titular designation of "primitive" and "evolved." While remaining true as a general characterisation, yet these words will need to be supplemented by more specific designations should a sound working hypothesis result from Dr Tayler's observations. Mr. Galton's coinage, eugenics, having been widely accepted, suggests further utilisation. In respect of the robuster, coarser, more carnal and materialist type, the word palæogenic would at once resume its observational basis and leave scope for further terminological development in the study of type variants and their social environment. In the same way the correlative word neogenic would designate the contrasted order, whether of environment or of organism, characterised by the finer, subtler, more cultural and idealist type.

Grant the conception of the two contrasted series of palæogenic and neogenic types as a fundamental principle of division in the classification of human types of character, and the centre of interest shifts to other than taxonomic issues. What, we ask, is or can be known of the historical development of these types in individual and racial evolution; what of the interaction between themselves as individuals and as groups; what of their environmental interrelationships; what of their future phases of evolution; what modification may be consciously devised; what ideals consciously promoted? And, moreover, each of these

questions has to be asked alike on many planes—biological, psychological, economic, ethical, &c. Thus does every initiative in science open up a whole system of new lines of investigation. The student who gives himself to Dr. Tayler's guidance will be carried no little distance along several of these new lines of research; and, moreover, it will be surprising if, after that initiation, the student does not himself acquire the momentum of original investigation, for evolutionist conceptions are applied by Dr. Tayler with a fertility and a novelty as courageous as their results are inspiring.

His evolutionist doctrines cannot be adequately summarised in the space here available. But two of his main contentions may be noted. Looking at western civilisation from the environmental point of view, he sees two large formative processes at work. There is a process which operates in the direction of selecting the palæogenic types and eliminating the neogenic; and there is a process which sociologically runs counter to this, and operates in the contrary direction, tending to select the neogenic types and eliminate the palæogenic. The social environment which, in its characteristic domestic and occupational phases, pertains to the plutocratic and the aristocratic scheme of life is, in point of selective efficacy, stated to be the sociological equivalent of the disease and poverty, the crime and vice of the urban slums. In contrast to the social selection exercised alike by impoverished and luxurious environments, Dr. Tayler finds the counter process in the cultural activities associated with most professional and some artisan occupations.

Such being the speculative foundations, it will be readily seen that Dr. Tayler's practical policy of social progress lies in environmental modification consciously planned by the scientific sociologist. The immediate practical question thus resolves itself into asking who and where is the scientific sociologist and what are his credentials? The human control of environmental modification has hitherto—at any rate since the Reformation—lain with the statesman and politician, and such theoretical guidance as the practical reformer has received from theologian and historian, and in later times from economist and journalist, has not been without a certain element of scientific foundation. But the guidance of a new spiritual order is appearing. Indications of this are visible on all sides. To say nothing of Mr. Wells and other competent popularists, examples may readily be drawn from more recondite sources. By the president of the Scottish College of Physicians, medical men were recently exhorted, with missionary fervour, to organise a crusade for the development of a hygienic conscience. From the rostrum of the Sociological Society Mr. Galton has preached a eugenic conscience. A recent presidential address of the Anthropological Institute came very near to preaching an ethnic conscience; and have not the psychologists for half a generation or more been preaching a pedagogic conscience?

It is indeed manifest that we are here in contemplation of that most thrilling spectacle of human drama—the birth-throes of a new spiritual power. And in the new spiritual orders there will be, as always in the past there have been, individuals of the militant type—brethren not content with crook and cassock, book and bell, but demanding the sword of temporal power. In this respect the observation may be made that great as is the theoretical and scientific interest of Dr. Tayler's book, yet its practical symptomatic interest is perhaps still greater; for it is diffused with the militant spirit, and thus it becomes a matter of political concern to ascertain how many fighting brothers of Dr. Tayler's calibre are to be found in the order of the Neo-æsculapians.

ELECTRICITY, OLD AND NEW.

Propagation de l'Electricité. By Marcel Brillouin. Pp. vi+398. (Paris: A. Hermann.) Price 15 francs.

IN this book we have a reproduction of a course of lectures delivered by Prof. Brillouin at the Collège de France during the session 1902–03. They were presumably addressed to an audience possessing already a fair knowledge of electrical theory. The author, therefore, does not aim at giving a complete and connected account of the subject, but, with a freedom which less fortunate teachers will envy, selects those parts which seem to him most interesting from a historical or theoretical point of view. The subject matter of the course now published falls under two heads; first, an exposition of fundamental principles, characterised by great fulness in the historical setting and originality in the order adopted, and second, a detailed discussion of certain special problems. The style is admirably clear, and the whole book is written with a freshness which makes it very interesting reading.

The title is taken to cover steady as well as varying currents. Accordingly, the first four chapters are devoted to an account of the work of the pioneers, beginning with Cavendish—that wonderful human electrometer who estimated P.D. by the kick in his elbows—and coming down to Kirchhoff and Clausius. The author traces very clearly the gradual progress towards definiteness in the ideas of the magnitudes which figure in Ohm's law. Of Ohm's work a specially full account is given; stress is laid upon the fact that Ohm, in formulating his theories, was influenced constantly by the desire to coordinate experimental results, and was not, as is sometimes represented, guided merely by an *a priori* analogy between thermal and electrical phenomena.

Following this historical introduction we have the development of the theory of conduction in three dimensions. Among the special cases dealt with are the resistance of a circular cylinder treated by Bessel's functions, and the "end-correction" for a wire by Lord Rayleigh's method of approximations.

The discussion of varying currents is next taken up, beginning with the case in which the influence of capacity only needs to be considered. An excellent account is given of Lord Kelvin's theory of the cable.

The author, here and elsewhere, keeps in close touch with the actual experimental conditions, and makes frequent reference to the historic controversies of the early days of long-distance signalling. This chapter is followed by an account of the author's investigation of the electrostatic field associated with a given current system. An interesting special case is worked out in detail, viz., the two-dimensional field produced by a current sheet flowing round an infinitely long cylinder, an impressed E.M.F. being localised in a generator.

In the treatment of induced currents which follows, Prof. Brillouin departs widely from the order of ideas now usually adopted. He confines the discussion to fixed circuits in a uniform non-magnetic medium, and takes as starting point Felici's experiments on the induction of currents in a secondary circuit, by making or breaking a given current in a primary. Proceeding in the old action-at-a-distance manner, he gets first a formula for the inductive action of an element of the primary circuit on an element of the secondary, and from this obtains the coefficient of mutual induction and the vector potential. Some cases of induction coefficients are worked out, and then follows an exhaustive and critical analysis of Kirchhoff's great memoir of 1857, in which the finite rate of propagation of electric effects along a wire was established.

Perhaps the most novel feature of the book, at least to an English reader, is the way in which the question of open circuits is approached. The author begins by adding to his vector potential a term which goes out on integrating round a closed path. This term is affected by an arbitrary constant which appears also in the complete electric force derived from the new vector potential. The value of this constant is then chosen so as to make the divergence of the electric force still equal to 4π times the charge. This preserves what the author calls the "unity of the electric force," *i.e.*, it makes the ponderomotive force on unit charge identical with the current-producing force which enters into Ohm's law. When we have reached this point we find that the new term in the vector potential has given us Maxwell's displacement current. It is then shown that its identification as a true current makes all currents closed, and is justified by its electromagnetic effects. The magnetic force is then introduced "pour la commodité de langage," as the vector the time-rate of which is the curl of electric force; and such things as magnet-poles need not exist at all.

To readers brought up on Maxwell and Heaviside this electrostatic method of arriving at things will come as a sharp disturbance to the "normal piling" of their electrical ideas. A similar disturbance would be produced in the theory itself by the introduction of a little iron into its system. We shall probably understand the reason for the adoption of this procedure if we remember that Prof. Brillouin wrote when "l'affaire Crémieu" was at its height, and before Pender crossed the Atlantic to see what the matter was. An exposition which linked Maxwell's views to the earlier theories was specially natural at that time, in view of the doubts suggested touching relations which had come to be regarded as the "solid ground of Nature." If a revision of belief had been shown to be necessary, some such harking-back to earlier positions as is displayed in the present book would have become essential.

The concluding section of the lectures is occupied with a discussion of the problems of the Hertz oscillator and of the oscillations proper to spherical and spheroidal conductors. A full account is given of the recent work of Prof. Pearson and Miss Lee on the field of the Hertzian doublet as modified by the damping of the oscillations. In the discussion of the spheroid the author supplements the work of Abraham and Maclaurin, specially in the direction of numerical evaluation of the functions involved.

W. B. M.

MILK IN RELATION TO DISEASE.

Bacteriology of Milk. By Harold Swithinbank, of the Bacteriological Research Laboratory, Denham, and George Newman, M.D., D.P.H., Medical Officer of Health of the Metropolitan Borough of Finsbury, and formerly Demonstrator of Bacteriology in King's College, London. With special chapters also by Dr. Newman on the Spread of Disease by Milk and the Control of the Milk Supply. Pp. xx+605; illustrated. (London: John Murray, 1903.) Price 25*s.* net.

THE public is beginning to recognise the importance of milk and its products from the dietetic and hygienic point of view, and public authorities are becoming alive to the necessity for safeguarding the milk supply from adulteration, from the addition of preservatives, and from contamination with filth and the germs of disease. The appearance of this work, a large volume of 600 pages, is therefore opportune. It is a treatise on milk in its relation to disease rather than, as its title implies, an account of the general bacteriology of milk, for while such subjects as the souring of milk and the various fermentations it undergoes are dealt with in 55 pages, tuberculosis in relation to milk, epidemics of disease due to infected milk, the legal enactments regulating milk supply, &c., occupy some 350 pages.

As a general criticism, in the reviewer's opinion some of the matter introduced might without detriment have been omitted, thereby giving more space to certain subjects that at present receive somewhat scant treatment. Thus an attempt has been made to deal generally with bacteriological technique, the preparation of culture media, and examination of water and air, instead of limiting the matter in these directions to that special to the subject. The pages on the agglutination reaction, on preventive inoculation in enteric fever, and on the bacteriological diagnosis of diphtheria seem to be quite unnecessary. The chapter on the description of species of milk bacteria, occupying some 60 pages, also gives for the majority

of species so few details that in its present form it is of little value. This may be the fault of the subject rather than of the authors, but had an attempt been made to give a key-index to the species and their recognition, this would have been of much use. With these reservations, the authors are to be congratulated on having produced a work which must for some time to come remain the standard one on the subject.

The tubercle and acid-fast bacilli met with in milk and the biology of the tubercle bacillus are fully and adequately treated, and a number of coloured and other illustrations of cultures and colonies are given which will be of the greatest service to those who are unable to consult original papers. As regards the relation of bovine and human tuberculosis, a judicial and judicious summary is given, and the authors express the provisional opinion "that tuberculosis in all animals is generally one and the same disease, but that it differs in various ways in different animals and according to the strain and virulence of the infecting bacillus. That human tuberculosis can be transmitted in certain circumstances to animals we do not doubt. There is also *prima facie* evidence to show that the reverse proposition is true, namely, that under certain conditions bovine tuberculosis is transmissible to man. We therefore look upon the two diseases as different species or varieties of one and the same generic disease and intercommunicable. Whilst we hold this view in respect to the communicability of tubercle, we do not for one moment suppose that its transmission through milk is very frequent or very widespread. The great field of infection in tuberculosis is from animal to animal, and from man to man, and cross-infection is probably less common than is generally supposed."

This opinion practically coincides with that expressed in the recent report of the Royal Commission on Tuberculosis. Dealing with outbreaks of epidemic disease due to an infected milk supply, scarlatina, enteric fever, diphtheria, epidemic diarrhœa, cholera, &c., receive attention, and the details of many of the principal outbreaks are summarised. As regards the celebrated Hendon outbreak of scarlatina, the whole of the facts is stated, and not a portion only, as is generally the case, and the authors conclude, "we are of opinion that the exact origin of the London epidemic at that time has not yet been, and now probably never will be, demonstrated." It is to be hoped that future writers on the subject will note this.

The last portion of the book deals with the control of the milk supply (*a*) by the State, and (*b*) by private enterprise, with useful appendices on legal enactments and model regulations for dairies, &c. The summary on milk legislation in the various countries of the world is especially to be commended. Tuberculin is touched upon, and the old and the new tuberculins are described, but no mention is made that it is the *old* tuberculin which is employed for cattle testing. The sections dealing with pasteurised and sterilised milk are very brief, and might well be expanded in a future edition, while condensed milks seem to be unnoticed. The book is well produced and illustrated, but the index might with advantage be fuller.

R. T. HEWLETT.

OUR BOOKSHELF.

Handbook to the Natural History of Cambridgeshire. Edited by J. E. Marr and A. E. Shipley. Pp. viii+260: (Cambridge: University Press, 1904.) Price 4s. net.

THE little volume before us affords an excellent example of the thorough-going and careful manner in which every detail connected with the late meeting of the British Association at Cambridge was thought out and worked out by the responsible executive. As a matter of fact, the volume in question is likely to be much more than a mere ephemeral production, and will probably take its place as one of the standard text-books in the scientific teaching of the university; for it will scarcely be disputed that a thorough knowledge of the natural history of the district in which the student resides is one of the very best aids towards attaining a comprehensive grasp of biology and geology in general. The term natural history, it should be mentioned, is employed in this work in its very widest and most extensive sense, embracing not only zoology and botany, but likewise geology and palæontology; while the scope of the undertaking is still further increased by an excellent chapter on prehistoric archæology.

For the planning and supervision of a work of this nature no better editors could possibly have been found than Messrs. Marr and Shipley, the one gentleman being an eminent authority on geology in general, and that of the district in particular, while the other is no less distinguished as a biologist. Dr. Marr, in collaboration with Mr. Fearnsides, has contributed the introductory chapter on physiography, but Mr. Shipley has contented himself with purely editorial functions. For the other chapters of the work the editors have been fortunate in securing the (gratuitous) services of a number of specialists, at least two of whom happened to be engaged on the natural history of Cambridgeshire for the "Victoria County History," and were permitted by the council of that undertaking to make use of their labours for the benefit of the volume before us. Hitherto no complete lists of the fauna of Cambridgeshire appear to have been published, and Mr. H. H. Evans's account of the birds of the county may be cited as an excellent example of the manner in which such local faunas should be described. It was somewhat unfortunate that in the account of the vertebrate palæontology of the county the introduction of a personal element was unavoidable; but the proposal contained therein, to name a species after the well known palæontologist whose work is criticised, may be taken as an indication of the absence of any trace of ill-feeling on the part of the writer.

Both editors and authors are to be congratulated on the production of such an excellent and comprehensive local "natural history" in such a smal compass, the permanent value of the work being largely increased by the beautifully coloured geological map of the county.

R. L.

Theorie der Elektrizität und des Magnetismus. By Dr. I. Classen. Band i. Electrostatik und Electrokinetik. Pp. x+184. (Leipzig: G. J. Göschen, 1903.)

THE conventional text-book of electricity starts with the supposition that the forces exhibited by electrified bodies can be attributed to a something called electricity which resides on material bodies. Quantitative laws are developed, and we are led up to the Faraday-Maxwell conception of the medium as the real seat of electrical action.

Prof. Classen, like many others, finds this method unsatisfactory. The first view presented is too narrow; its arbitrary character cannot always be realised, the

development is often hap-hazard, and the mental revolution required before Faraday's idea can be assimilated generally proves troublesome to the student.

The author's view, then, so far as we can gather, is that the subject should be developed from Faraday's standpoint. With this we are in complete sympathy. But the problem of writing a text-book from a new order of thought is no easy matter, and the first portion of the volume is distinctly disappointing. There are frequent relapses to the old method, the treatment is somewhat laboured, and the result, so far from being inspiring, is confusing and inconclusive.

In the latter part of the volume the author treats of electrical currents, and the fundamental laws are developed without the introduction of the magnetic properties. This is distinctly good, and, although not quite new, will commend itself favourably to those who take an interest in the philosophical and logical presentation of the subject.

We cannot help thinking that the author is somewhat misguided in pushing a hydrodynamical analogue to the extent he does. It is difficult to reconcile the suppositions that velocity corresponds to electrical force, and pressure to electrical potential. Chapter x. is devoted to "an extension of this hydrodynamical picture." We are of opinion that when an analogy becomes so troublesome that a chapter is required to expound its additional artificial properties, it has ceased to be of any assistance, and the sooner it is dropped the better.

Die Keimpflanzen der Gesneriaceen. By Dr. Karl Fritsch. Pp. iv+188. (Jena: G. Fischer, 1904.) Price 4.50 marks.

The Gesneriaceæ are generally familiar to horticulturists and others, since the order includes several favourite greenhouse plants, to mention only Ramondia, Saintpaulia, Achimenes, Streptocarpus, and Sinningia, of which one species passes as Gloxinia. The morphological peculiarities of these and other less known genera are not so familiar, in fact, it has been the object of Dr. Fritsch to find their correct interpretation by the aid of cultivation and examination of such seedlings as he was able to obtain. Some of the principal morphological features are the tuber-bearing plants of which Sinningia is a type; vegetative scale-covered runners which propagate the plant, characteristic of Achimenes and Kohleria (Isoloma); and the unequal development of cotyledons which is well known to cultivators of *Streptocarpus Wendlandi*. The unequal development of the cotyledons is regarded by the writer as a special case of *anisophylly*, for which he proposes the term *anisocotyly*; in this connection there is a discussion of the views put forward by Wiesner and Goebel on anisophylly, and it is shown that some modification is required in order to explain anisocotyly. A further irregularity in the case of *Klugia Zeylanica* and some species of Streptocarpus is the displacement of the cotyledons from the opposite to an alternate position; this is attributed to the intercalary development of an internode between the cotyledons, to which the name of *mesocotyl* is given.

The scale-bearing runners have been variously described; they resemble bulbs in so far as the leaves are swollen into food reservoirs, but they differ therefrom because the stem is elongated and also contains reserve food material, and the swollen leaves may be closely packed, when the runner resembles a pine cone, or the leaves may be loosely arranged; on this account Dr. Fritsch prefers to call them *bulbshoots* (Zwiebelsprosse), and he would include under this designation the similar bodies which are found on species of Epilobium, Oxalis, Saxifraga, and Dicentra.

Dr. Fritsch confirms Lubbock's statement that the tubers of Corytholoma (Gesnera of gardeners) and *Sinningia speciosa* (Gloxinia) are produced by the thickening of the hypocotyl, and adds that in the case of *Corytholoma cardinalis* the epicotyl also takes part in its formation. It is not possible to mention, much less to pass in review, the various morphological details, but enough has been said to show that the Gesneriaceæ, as an order, will repay careful study, and it should be added that this account of the seedlings is characterised by clearness and breadth of treatment, and the German is simple enough to suit the veriest tyro.

Das Leben im Weltall. By Dr. L. Zehnder. Pp. 125. (Leipzig: J. C. B. Mohr, 1904.) Price 2.50 marks.

Man and animals and plants all live, each in its degree. Lower than these is matter itself. Does it live? Do crystals live in their mother-liquid? In general, is the universe itself a living thing? These are the questions which a professor of physics of Munich attempts to answer in this small volume. We learn that the variations of matter, and those variations of plants and animals which are taken as special evidence of their vitality, are linked together in an unbroken chain. On the other hand, an exception is made in respect to the ultimate structure of the atom itself. In fact, a well defined boundary is found to separate substances of which inorganic bodies consist from substances which are necessary for the formation of organic bodies.

We can by no means pretend to have followed all the arguments put forward, even when they have purely physical reference. Thus, the author concludes that the æther has an atomic structure merely on the ground that, having decided that it is a substance, there is neither sense in nor justification for attributing to it any properties except those which other substances possess. This dogmatic style of reasoning is characteristic of the whole argument; and it certainly does not conduce to confidence when matters are discussed with which we are not so familiar.

First Stage Steam. By J. W. Hayward, M.Sc. Pp. 230. (London: W. B. Clive, University Tutorial Press, Ltd., 1904.) Price 2s.

Mr. Hayward is very happy in the treatment of his subject in his "First Stage Steam," written to meet the requirements of the examination of the Board of Education at South Kensington. After a short introductory chapter on mensuration and squared paper work, drawings of a simple horizontal steam engine are given, and the functions of the various parts are described in detail. This description occupies considerable space, and at appropriate intervals is made the occasion for the introduction of experiments and calculations bearing on the subject. The Lancashire boiler with its mountings is then well described, and this leads naturally to the consideration of combustion and the heat properties of steam. The reader is introduced to these by simple and striking experiments which he can make himself, and not until after this has been done is the student informed of the results of classical experiments on which heat calculations of the steam engine are based. The writer then, by the help of good illustrations, touches on the salient points connected with the design and working of modern locomotives, marine engines, internal combustion engines, and steam turbines. The reader is left with the impression that there is very much in the subject worthy of attentive study. A special feature of the book is the encouragement given to quantitative experimental work with simple apparatus which the student can make and use himself. The book is not free from slight defects, but is sure to give satisfaction wherever used.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Secondary Radiation due to the γ Rays of Radium.

IN a recent communication to the *Annalen der Physik* (4 and 5, 1904), Paschen described experiments showing that a thick lead block containing radium emits negatively electrified particles which can be deviated in a magnetic field. He concluded that he had deflected the γ rays, thus differing from previous experimenters.

I have found that particles having a negative charge are projected, and are readily deflected magnetically. However, these are not γ rays, but differ from them inasmuch as they are completely absorbed by about a millimetre of lead.

In order to prove this, an electroscope with a thin aluminium face was mounted on a lead platform (1·2 cm. thick) above a block of lead 10 cm. high, at the centre of which was placed 30 mg. of radium. On applying a magnetic field to bend the rays towards the electroscope, the electroscope readings were doubled, but this increase was reduced to half value by a screen of lead (0·1 mm. thick) placed in front of the aluminium face. Since negatively charged particles are thus projected from the lead surface, it is clear that, as Paschen observed, a block of lead, placed in a vacuum and well insulated, would acquire a positive charge, and would continue to do so as long as the radium emitted γ rays, even if these penetrated two or three inches of lead.

The effect which Paschen observed was due not to the primary γ rays, but to the diffuse secondary radiation caused by the γ rays in the lead. This may be shown to be mainly a surface effect, for the secondary radiation from a greater depth than one or two millimetres is absorbed by the lead itself. The curvature of the rays, necessarily implied by Paschen's second experiment, is so large that other experimenters could not have failed to detect it by direct methods had the effect been due to γ primary rays.

This deflection of γ secondary radiation by a magnetic field is similar to Becquerel's result, obtained photographically, when he deflected the β secondary rays. Curie and Sagnac have also shown that Röntgen rays striking a metal cause it to emit negative electricity and to acquire a positive charge; Dorn has proved that such rays can be deflected by a magnet.

Any experiment designed to prove that the primary γ rays can be affected by a magnetic field must involve evidence that the effect produced is not due to the easily deviated γ secondary radiation. A. S. EVE.

McGill University, Montreal, August 22.

A Source of the Ionisation of the Atmosphere.

IT is perhaps not very generally known that human breath has a considerable power of discharging an electrified conductor. This fact can be strikingly shown by an experiment easily carried out. If the discharging knobs of a Wimshurst electrical machine are drawn apart so far that a spark just refuses to pass, then on breathing across the gap the spark is instantly precipitated.

The discharging power of the breath is more conclusively demonstrated, however, by breathing through a metal tube into which an insulated metal rod projects axially, the insulation of the rod being out of reach of the breath. If the rod is connected to the cap of a graduated gold-leaf electroscope, comparative observations show that the rate of discharge of the electrified rod and gold leaves is 60 per cent. to 70 per cent. greater when air from the lungs is passing through the tube than when ordinary air fills it. Again, the rate of leak of a charged electroscope in a small, badly ventilated class-room, was found to be 50 per cent. more rapid when the room was full of students than when it was empty. Incidentally, this explains in part why experiments on electrostatics are often troublesome to carry out in a room crowded with a large audience.

The point of interest, however, in these experiments is the fact that the slow low-temperature combustion going on in the lungs ionises the air in the same way as the rapid high-temperature combustion of flames. And if this slow ionisation of the air can take place in the lungs of living animals, it may also go on less markedly in the chemical interaction between the air and living plants, and in some cases between the air and inorganic matter, at ordinary temperatures, so that there is here a continual source of atmospheric ionisation apart from any possible radio-active processes. J. R. ASHWORTH.

Rochdale, August 27.

Celtic Place-names.

THE review of Mr. Johnston's "Place-names of Scotland" in your number of July 28 explains a problem that has been for a long time a puzzle to me in reference to the existence in County Leitrim alone, of the thirty-two counties in Ireland, of the word "allt" in common parlance.

To North Leitrim there came over from Stirlingshire about the year 1608, as followers and soldiers of Sir Frederick Hamilton, grandson of the second Earl of Arran, a strong Scotch colony. From them we took in a great measure our English or Scotch-English. Here is a trace of it. A half-dozen others of our distinctive Leitrimisms I have already traced back to Scotland; others to elsewhere.

In odd words and odd uses of them, and in odd pronunciations, are found "helpful and interesting sidelights for the historian" (to use the reviewer's expression) all through Ireland. Indeed, the "Irish plantations," and the parts of England and of Scotland the planters came from, might be plotted out by a careful observation of such peculiarities. They are disappearing. Before it is too late, or it becomes too difficult, it would be well worth while for someone who knows the rural districts of both countries intimately to attempt the task. It should well repay the historian or the philologist. I have been trying something like it, but I have had slight opportunity for making the acquaintance of any English dialects except the Yorkshire and the Lancashire, and I cannot accordingly push it very far.

I have to thank the reviewer; but permit me to say that the Leitrim use of "allt" (or "alt") corresponds rather with that given by Mr. Johnston than with that claimed by him. With us an "alt" is not "a streamlet passing through a ravine," but a narrow, deep glen or hollow through which, as a rule, of course, a stream or streamlet flows; but that a stream should do this is not essential for the chasm to be so termed. Joyce, too, would support this. The word *alt*, he states ("Irish Names of Places," p. 353, 1869 edition), is found in townland names in Ireland, and in its topographical application it is generally understood to mean a cliff or the side of a glen.

I should be much interested in knowing if Mr. Johnston would subscribe to our precise application of the word. It is evidently a primitive word of Aryan origin. The meaning of all allied words in any language I am familiar with favours our interpretation, and it is hard to see how it could come by the meaning of "streamlet," however flowing. JOSEPH MEEHAN.

Creevelea, Drumkeeran, Co. Leitrim, August 5.

I HAVE read with much interest your correspondent's letter, and can well understand his difficulty with regard to the Scottish usage of the word *allt*. Here it is applied, as I have stated, to a stream passing through a ravine or hollow; never, so far as I am aware, to a glen or dry chasm.

The Irish *alt*, which is slightly different in spelling, is also apparently different in application. Your correspondent may be interested in the various Celtic usages of the word as given by Dr. Macbain in his "Etymological Dictionary of the Gaelic Language":

"Allt, a stream; Ir. alt, height, (topographically) glen-side or cliff; O. Ir. alt, shore, cliff; O. W. allt, cliff; Cor. als; Br. aot, shore, all allied to Lat. altus. The Gaelic form and meaning are possibly of Pictish origin."

Looking down or up the precipitous sides of many a

mountain stream, it is not hard to see how this epithet came to be associated with, and applied to, the stream itself, which is not regarded apart from its peculiar surroundings. The steep sides are, in fact, the characteristic feature of the ordinary Highland *allt*. THE REVIEWER.

The Striped Hawk-Moth.

WITH reference to the paragraph in NATURE of August 18 (p. 389) on the striped hawk moth, on May 23 this year I found a specimen alive in a thick bed of lily-of-the-valley; it had just emerged, and had never flown. Warmwell is two miles from the sea as the crow flies; possibly the parent was a migrant, but the moth I found had passed through its metamorphosis in this country. The insect lived twelve hours after capture, and is now in the collection of Mr. O. Picard-Cambridge, of Bloxworth.

Warmwell, Dorchester. ROSE HAIG THOMAS.

Mountains and Mankind.

I SHALL be obliged if you will allow me to correct the following errata in my address to Section E of the British Association. For "Watson" and "Tokio" read Weston and Kobi (p. 429, column 2).

September 5. DOUGLAS W. FRESHFIELD.

[The errors occur in the copy of the address reprinted in NATURE.—EDITOR.]

BRITISH CHEMICAL EXHIBIT AT THE ST. LOUIS EXHIBITION.[1]

THE Royal Commission appointed to arrange the British exhibits for the St. Louis Exhibition have evidently, from the catalogue before us, carried out their difficult task with great care and in a most successful manner. We would that all catalogues were written in the extremely interesting and vivid style of the one to which we have referred. The products treated of in the catalogue are drawn up in alphabetical order, and at the end of the description of each substance, or group of substances, the names of the exhibitors are placed; the exhibitors are also arranged in alphabetical order at the end of the book.

The catalogue is written in the form of a history of the various manufacturing processes described therein. First and foremost we come to a most interesting and detailed account of the alkali industry, from the time of its inception to the present day. The reader is carried historically through the building up of the Le Blanc process—and the tragic fate of Le Blanc, its founder—the ammonia soda process, Chance's sulphur recovery process, and so on. Many details, which are not the common property of text-books, as to the difficulties and failures and final success are included, which makes the narrative of exceptional interest. Before Solvay's time, several patents had been taken out which embodied the principles of his ammonia soda process, but he, unaware that others had worked upon the subject, experimented and patented the process, and we are shown in his own words what a blow he received on discovering that he was not the first in the field:—

"What was our astonishment in discovering . . . I was no longer the inventor of the reaction and its industrial use had already tempted other investigators. It was a hard blow to me."

Here the narrator intervenes with the pertinent words: "Happily Solvay was young," and finally success attended his efforts. In so far as the ammonia soda process affects the British exhibits, we have to thank the indefatigable energy of Dr. Mond.

As a natural sequence the manufacture of sulphuric acid is treated of in the same section as that devoted to the alkali industry, and after being informed that sulphuric acid was first made by Ward at Richmond in 1740, we are taken through the gradual development of the chamber process, and then introduced to the contact process, which may be said to have been originally founded on an experiment of Humphrey Davy in 1817.

The section on alum is very interesting, and one notices how greatly manufacturers in this country are indebted to the acumen of Peter Spence, of Manchester.

One of the most interesting and suggestive sections is that dealing with the coal-tar products. In his report on the 1862 Exhibition, Hofmann spoke with sanguine eloquence of the bright prospects before the coal-tar colour industry in this country. The brilliant anticipations which Hofmann made for England have, alas! not been substantiated, for where we have sown others have reaped. The writer of this section endeavours to trace some of the causes which underlie the loss of the colour industry to England—such as the inadequate patent laws, want of research, which really means want of sufficient capacity for looking ahead.

To the electrochemical industry are devoted nine pages of the catalogue, which, commencing with an historical survey of the foundation of electrochemistry, passes on to deal with hypochlorites, chlorates, caustic alkali, and sodium. Then follows a description of the copper refining processes, and on p. 87 we are told that other metals, such as gold and silver, have been purified by electrolytic processes. As these have not been done in the United Kingdom, this is evidently in the nature of a hint to British electrochemists. A passing reference is made to the manufacture of calcium carbide, which, we regret to say, is at present not manufactured in this country.

We have only picked out a few of the subjects treated of in the catalogue; there are, of course, many others, such, for example, as explosives, the candle industry, soap, oils and colours, and so on.

There are also a good many scientific exhibits, among which may be noted Sir James Dewar's low temperature research exhibit, in which the complete plant, as employed at the Royal Institution for the production of liquid and solid hydrogen, is shown. Photographs of spectra by Mr. E. C. C. Baly, exhibits from the Lister Institute of Preventive Medicine, also a very complete exhibit from the Wellcome Research Laboratories, and many others which space forbids us to mention.

We do not know whether the catalogue is on sale in this country, but we recommend all interested in the manufacturing and scientific advancement of the country to endeavour to procure a copy; because the exhibits demonstrate that, in spite of the keen competition of Germany and other nations, Great Britain can still claim to be high up in brilliant achievements in chemical and allied sciences. F. M. P.

[1] Catalogue of British Exhibits; International Exhibition St. Louis, 1904. Department C, Liberal Arts; Chemical and Pharmaceutical Arts. Issued by the Roya Commission.)

THE LIMNOLOGICAL STATIONS ON THE LAKE OF BOLSENA.

TWO years ago the executive committee of the Italian Geographical Society determined to undertake the desirable work of preparing an exhaustive monograph on one of the lakes of Italy, and they very naturally selected the Lake of Bolsena for the purpose. Its situation within easy reach of Rome,

its size, depth, and geological relations, the beauty of its environment, and the unique charm of the two picturesque volcanic islets Martana and Bisentina, all combine to render the lake attractive.

Before the preliminary operations of the Geographical Society, very little was known about the lake except with regard to the geology and morphology of its basin; the contours of the bottom had been carefully mapped by De Agostini, who had made no fewer than 3000 soundings. No regular observations of the seasonal temperatures of its waters or of the variations in their level, of *seiches* or of lacustrine plankton, had ever been carried out.

From a preliminary report prepared by Prof. Luigi Palazzo,[1] we learn that limnological stations equipped with Sarasin's limnograph and with other instruments have been established on opposite sides of the lake at Bolsena and at Marta, and that at chosen points in the immediate vicinity five meteorological stations are to yield continuous records of the rainfall and air temperature. A gauge for measuring the height of the water has also been fixed to a pier in the Fiume Marta.

One of the most interesting phenomena of which a continuous record will be kept are the *sesse* or *seiches*, the rhythmical oscillations of the surface of the lake,

FIG. 1.—Isola Martana.

which have a regular period of 12 to 15 minutes, and are more conspicuous at Marta than at Bolsena, apparently on account of the position of the former village nearer the major diameter of the lake, and on account of differences in the declivity of the bottom. A rise of the water of 7 inches at Marta was noticed to be correlated with a rise of only 4 inches at Bolsena. On occasions the rise of water may amount to a foot, and the seiches are then so noticeable that the common folk, in their expressive dialect, declare that the lake is panting (*trenfia*).

We hope that the full reports on the physical problems connected with the lake may soon appear, and that the investigation of the plankton will not be forgotten.

R. T. GÜNTHER.

NOTES.

IT is proposed to fix a standard time for use upon all Indian railways and telegraphs, which shall be exactly $5\frac{1}{2}$ hours in advance of Greenwich time, and to fix for Burma a standard $6\frac{1}{2}$ hours in advance of Greenwich. The Government of India has intimated that it is in favour of the adoption of the new standard for general as well as for railway and telegraphic purposes, and is prepared to cooperate in any movement with this end in view; but as the matter is one upon which the local communities should be consulted, the opinions of the Chambers of Commerce upon the proposals are being sought by the Government.

[1] "La Stazione Limnologica di Bolsena." Pp. 19; 9 figs. 1 pl. (*Boll. Soc. Geogr. Ital.*, v. 1904.)

THE death is announced of Dr. Petr Petrovic van der Vliet, emeritus professor of physics at the University of St. Petersburg, aged sixty-five.

AT the beginning of next month Prof. H. Battermann, observer at the Berlin Observatory, will take the position of professor of astronomy at Königsberg University, and director of the observatory there.

IN a message from Ponta Delgada (Azores) on September 1, Captain Scott states that the Antarctic ship *Discovery* may be expected to arrive at Spithead about September 10.

A LIFE-SIZED bronze bust of the late Sir Richard Temple was unveiled last week in the parish church of Kempsey, near Worcester, by the Earl of Coventry, Lord Lieutenant of Worcestershire. The inscription is as follows:—"The Right Hon. Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L., LL.D., F.R.S., sometime Governor of Bombay and Finance Minister of India, and M.P. for Evesham and Kingston."

THE Chancellor of the Exchequer has appointed the following gentlemen to serve as members of a committee to inquire into the use of duty-free alcohol for industrial purposes:—Sir Henry Primrose, K.C.B., C.S.I., chairman; Sir William Crookes, F.R.S.; Sir W. H. Holland, M.P.; the Hon. J. Scott-Montagu, M.P.; Mr. Lothian D. Nicholson; Dr. W. Somerville; Dr. T. E. Thorpe, C.B., F.R.S.; and Mr. Thomas Tyrer.

THE fifteenth annual general meeting of the Institution of Mining Engineers will be held at Birmingham on September 14. The following are among the papers to be read, or taken as read:—The mining department of the University of Birmingham, Prof. R. A. S. Redmayne; coal-mining in Asturias, Prof. Henry Louis; the problem of Gob-fires, Mr. George Farmer; an improved apparatus for laying the dust in coal-mines, Mr. J. Creswell Roscamp; mine-surveying instruments, part ii., Mr. Dunbar D. Scott; and the problem of dynamic balance, Mr. E. H. Roberton.

THE latest proceedings of the Indian Tea Association contain several items of interest in connection with the proposed scientific experimental station in Assam. We learn from the *Pioneer Mail* that the scientific adviser of the association recently explained his proposals for the permanent location of his assistant in Assam, for the provision of a laboratory for him, and the initiation of experiments in tea culture under his direct supervision and control. An offer has been made by the agents of the Scottish Assam Tea Company to provide a small bungalow and tea for experiment in the immediate neighbourhood of the bungalow, and further land for experiments as required. It was decided to accept the offer of the Scottish Assam Tea Company, and arrangements have been made for the erection of a laboratory.

IN connection with the recent announcement of the death of the Rev. George Pirie, LL.D., professor of mathematics in the University of Aberdeen, the following particulars may be of interest. Dr. Pirie was born at Dyce on July 19, 1843, being the eldest son of the Very Rev. Principal Pirie. His early years were spent at Aberdeen Grammar School,

and he afterwards studied at the university in the same town. In 1863 he entered at Queens' College, Cambridge, and three years later took the mathematical tripos, obtaining the degree of fifth wrangler. He was subsequently elected to a fellowship at Queens' College, where he also held office both as mathematical lecturer and as college tutor. In 1878 Dr. Pirie was elected to the chair of mathematics at Aberdeen University, which he held until his death. Dr. Pirie's interest in mathematics does not appear to have carried him much beyond ordinary routine work, as his name does not appear as the author of papers in the leading mathematical journals to which reference has been made in connection with the present notice. He, however, published one text-book, entitled "Lessons in Rigid Dynamics."

Most of our readers remember that the year 1903 was one of unusually heavy rainfall. "British Rainfall" for that year, recently published, contains tables of nearly 4000 stations, and supplies every possible information upon the subject that can be wished for. The work has been issued in practically the same form since 1861, a fact which, we consider, much enhances its value; but the materials have continually increased, and its size has been doubled in the last thirty years. The volume before us has, moreover, several important additions, *e.g.* a section dealing with the duration of rainfall, and rules for rainfall observers. Special articles deal with the extraordinary excess of precipitation in June (accompanied by useful maps) and with the three wettest years in the annals of "British Rainfall," viz. 1872, 1877, and 1903. Dr. Mill states that only one other year earlier in the nineteenth century can compare with them, and that is 1852. Whereas the average annual rainfall of the British Isles is 39·5 inches, 53 inches fell in 1872, 51 inches in 1877, and 52 inches in 1903, an excess of 32 per cent. The total rainfall over England and Wales during three days, June 13 to 15, is estimated at 5348 million tons.

We have received from the Government Astronomer of Western Australia (Mr. W. E. Cooke) a copy of the meteorological observations made at the Perth Observatory and other places in the colony during 1902. Morning and evening weather forecasts—the latter intended for newspapers—form part of the routine work, and are very successful; in fact, complete failure is of very rare occurrence. In connection with forecasts, Mr. Cooke states that the prediction of rainfall throughout the interior, for several days in advance, was attended with complete success, and that the experiment indicates a forward step in practical meteorology. In addition to monthly and yearly summaries for a number of stations, the report contains coloured maps showing for each month and for the year the mean distribution of the various elements over the whole of the colony.

In a communication to the Société Française de Physique, No. 216, 1904, M. Bouty describes experiments on the dielectric cohesion of argon and mercury vapour. The dielectric cohesion of argon is exceptionally small, its value being only about one-seventh of that of hydrogen. The smallest trace of impurity increases the value, and the author recommends the measurement of the dielectric cohesion as a means of testing the purity of argon, the sensitiveness of the test being comparable with that of the spectral examination.

We have received from the author, Dr. F. Braun, a reprint of an important paper appearing in the *Physikalische Zeitschrift* (No. 8, pp. 194–9) entitled "Methoden zur Vergrösserung der Senderenergie für drahtlose Telegraphie." Dr. Braun discusses the limits of the possible increase of capacity and voltage—and therefore of energy—of the usual sending devices employed in wireless telegraphy, and describes many new arrangements consisting of combinations of capacities and inductances for which considerably greater efficiency is claimed.

Dr. Braun also sends us a copy of an article on "Herstellung doppelt brechender Körper aus isotropen Bestandteilen" (*Physikalische Zeitschrift*, No. 8, pp. 199–203), in which he suggests that a doubly refracting body may consist in a homogeneous mixture of isotropic particles of two kinds the dielectric constants of which are different, the distribution of the particles being regular, but different in three principal directions. In illustration of the suggestion, experiments are described in which the body consisted of fire-bricks with air spaces between them. On passing plane-polarised electric waves through different thicknesses, the waves on issuing exhibited plane, circular, or elliptic polarisation according to the thickness of the body through which they passed. The experiments were conducted on a somewhat gigantic scale.

In No. 1, vol. ix., of *Terrestrial Magnetism and Atmospheric Electricity*, the aims and organisation of the department of international research in terrestrial magnetism of the Carnegie Institution are defined. The director is Dr. L. A. Bauer. Of the first allotment of 20,000 dollars, one half is to be devoted to office expenses, comprising the reduction, discussion, &c., of existing data, the second half being reserved for observational and experimental work. If satisfactory results are obtained during the first year, the same sum of 20,000 dollars is to be granted annually to the department. The aim of the department is to undertake investigations of an international character which are not specifically the subject of inquiry of any one country, such, for instance, as a magnetic survey of ocean areas and unexplored regions, observations of the variation of the earth's magnetism, and magnetic observations in ocean depths and in atmospheric regions.

We have received Nos. 6 and 7 of the series of monographs now being published under the title of "Attualità scientifiche," by Nicola Zanichelli, of Bologna. No. 6 (pp. 68) is a reprint of a lecture, delivered before the Italian Electrotechnical Association by Prof. Augusto Righi, on our present knowledge of radium. No. 7 (pp. 141) is a useful summary by Lavoro Amaduzzi of the investigations which have hitherto been made of the physical properties of selenium, particularly as regards the variation of its electrical properties under the influence of light; the practical application of the element in the photophone and in telephotography is dealt with in detail. As each monograph is written by a specialist, the series is likely to be of use not only to the general scientific reader, but also to those workers who are investigating the problems dealt with. Thus in the number dealing with radium, there is a description of new forms of the gold-leaf electroscope and of the torsion-balance which are suitable for detecting and measuring minute traces of radio-activity, whilst the treatise on selenium is of particular value on account of the complete bibliography of the subject which it contains. We may note that the earlier numbers of the series deal with the discharge of electricity through gases, with "chemical problems of the new century," with morphological and chemical evolution, and with the biological problem of the determination of sex.

IN the *Zeits. fur Instrumentenkunde* for July Messrs. Elster and Geitel describe a new form of apparatus for measuring the radio-activity of soils and of the mud or sediment of thermal springs. The increase in the conductivity of a constant volume of air, which is caused by its exposure, in a metal cylinder, to the action of the radio-active material, is measured by means of a modified form of Exner's electroscope. The especial features introduced into the electroscope are the insulation of the aluminium leaves by means of amber, and the production by means of metallic sodium of a dry atmosphere in the space in which the leaves are suspended. Measurements which were made of the ionising power and of the rate of decay of the emanation of "fango" or mud from the hot springs of Battaglia, would indicate that its activity is due solely to the presence of radium. In a paper contained in the June number of *Terrestrial Magnetism and Atmospheric Electricity* the same authors put forward the view that the conductivity of the atmosphere is largely, if not entirely, due to a radio-active emanation which issues from the earth's crust. In support of their contention, they have observed that the conductivity of air in closed cellars and in deep holes or wells is sometimes fifty times as great as that of normal air. Their view would also explain the fact that at low barometric pressures the conductivity of the atmosphere is much greater than at higher pressures, for a low pressure would favour the escape, from the fissures of the earth's crust, of the radio-active emanation. It is also possible that the electric phenomena which occur over the crater of a volcano are caused by an active emanation accompanying the vapours issuing from the crater.

WE are indebted to Mr. Quaritch, of Piccadilly, for a copy of a catalogue of rare and valuable works, including many on biological and sporting subjects.

THE report of the Maidstone Museum for 1903 records the capture in Maidstone of an apparently freshly-emerged specimen of the silver-striped hawk-moth (*Chaerocampa celerio*). Although the larva has been from time to time observed in the country, English specimens of this moth are generally considered to be immigrants from the Continent. Other specimens are stated to have been taken in England in 1903, but the last great "celerio-year" was 1885.

THE most striking feature of the report of the Field Columbian Museum for 1902–3 is formed by two plates representing groups—the one of the dibatag, or Clarke's gazelle, and the other of the spotted hyæna—mounted in the museum. Of the dibatag no less than six individuals, of different ages and sexes, are exhibited, one of the bucks being mounted in a characteristic attitude, with the neck and tail erect. It is a matter for regret that funds and space are not forthcoming for mounting groups of this nature in our own Natural History Museum. One day it will be too late to do so. We have also received from the Field Museum copies of two papers by Dr. D. G. Elliot on new mammals.

"DINOSAUR-HUNTING" in the Como Bluffs of Wyoming, according to the graphic description given by Prof. H. F. Osborn in the September number of the *Century Magazine* under the title of "Fossil Wonders of the West," must be an exciting sport, and one in which there are few blank days. The Bone Cabin Quarry, which was accidentally discovered in 1897, seems, indeed, to be the richest deposit of dinosaurian remains hitherto known—so numerous being the weathered-out bones that the shepherds actually built their huts from the vertebræ and ribs. "Here," writes the author, "are the largest of the giant dinosaurs closely mingled with the remains of the smaller but powerful carnivorous dinosaurs which preyed upon them, also those of the slow and heavy-moving armoured dinosaurs of the period, as well as of the lightest and most bird-like of the dinosaurs. Finely rounded, complete limbs from eight to ten feet in length are found, especially those of the carnivorous dinosaurs, perfect even to the sharply pointed and recurved tips of their toes." From this wonderful mausoleum Prof. Osborn estimates that remains of no less than 73 individuals were obtained by his party; but, inclusive of the weathered-out bones, it may be conjectured that the total must have reached at least 100 head. The area probably represents an old river-bar, the still waters of which arrested the course of the carcases on their seaward journey. The paper is illustrated by excellent restorations from the facile pencil of Mr. C. R. Knight.

TWO important contributions to our knowledge of the chimæroid fishes of Japan are made by Prof. Dean in the *Journal* of the College of Science of Tokyo University (vol. xix., articles 3 and 4). In the first of these the author treats of the two Japanese species of true chimæra (*Chimaera phantasma* and *C. mitsukurii*) and their egg-cases. Of the former species it is stated that while sometimes the fishermen will catch from twenty to thirty specimens a day in water varying between 50 and 300 fathoms in depth, on other occasions they do not find a single example for days. Although sluggish in their movements when kept in baskets in shallow water (where they soon die), there is reason to believe that in their normal haunts these fishes display considerable activity. Their egg-cases are larger than those of any other species. In the second memoir, Prof. Dean discusses the structure and affinities of the long-snouted chimæra (*Rhinochimaera pacifica*), which has been made the type of a genus by itself, although there is some doubt whether it is really entitled to generic distinction from *Harriotta raleighana*, obtained in deep water about 1894 by the *Albatross* near the Bermudas. The most interesting feature observed in the type specimen of the former was the complete distinctness of the palato-quadrate-bar from the cranium proper, this being thought at first to indicate that the skull was not of the true autostylic type. Other specimens showed, however, that the feature was not constant, although its existence in even one specimen tends to support the view that the autostylic skull of the Dipnoi is a specialised derivative from the hyostylic type characteristic of the fringe-finned ganoids.

THE most recent addition to the literature of cotton cultivation issued by the Imperial Department of Agriculture for the West Indies constitutes No. 31 of the pamphlet series, and is entitled the "A.B.C. of Cotton Planting." The method is adopted of providing the information in the form of question and answer, which combines brevity and precision.

CONTINUING his researches into the parthenogenetic development of embryos of *Thalictrum purpurascens*, Mr. Overton states in the May number of the *Berichte der deutschen botanischen Gesellschaft* that in these cases no reduction takes place in the number of chromosomes. The list of plants for which parthenogenesis has been established includes *Antennaria alpina*, species of Alchemilla, and *Taraxacum officinale*.

IN the first part of the *Bulletin* of the Imperial Society of Naturalists of Moscow, Mr. J. Gerassimow adds another paper to his contributions to the physiology of the cell. In cultures of *Spirogyra crassa* and allied species he obtained abnormal cells, without nuclei, or with excess of nuclear matter, or with two nuclei, by cooling the cultures in which the filaments were in an active stage of division. The result of changing the proportion of nuclear substance to cell contents was to cause irregularity of growth, so that where the nuclear substance was in excess, cell division was retarded, but general growth accelerated.

WE have received a copy of a pamphlet entitled the "Advantages of Ambidexterity," which may be obtained from Messrs. Sampson Low, Marston and Co., Ltd., price 6*d.* The booklet contains a lecture, delivered before the Ambidextral Culture Society by the honorary secretary, Mr. John Jackson, dealing with the "advantages accruing to any and every individual who may acquire the faculty of using both hands with equal facility."

AN unpretentious magazine has just appeared under the title of *Discovery*; and it merits encouragement because its aims are to publish trustworthy information on scientific and other topics. In the first number, Dr. J. Oldfield writes on diet, Dr. Edith Temple Orme on the modern education of women, Mr. A. A. Buss on spectroscopy, and Mr. A. C. D. Crommelin on the total solar eclipse of August 30, 1905. Other subjects of popular interest are dealt with in shorter contributions. The editor is Mr. G. McKenzie Knight, and the London agents Messrs. Bensberg Bros., 7 Electric Parade, Seven Sisters Road, N.

THE Cambridge Scientific Instrument Company has just issued a useful illustrated list under the title "Technical Thermometry." It is a new, revised, and enlarged edition of an earlier catalogue entitled "The Measurement of Temperature by Electrical Means." Copies of the list may be obtained on application to the company. Among the chief contents may be mentioned sections dealing with electrical resistance thermometers, thermoelectric thermometers, continuous temperature recorders, and electrical resistance furnaces. The excellent illustrations and full descriptions will render the list very serviceable to teachers and investigators.

OUR ASTRONOMICAL COLUMN.

THE LINE SPECTRUM OF COPPER.—Some exceedingly interesting results have been obtained by Mr. A. S. King at Bonn during a detailed study of the line spectrum of copper under many various conditions of arc and spark discharges. Mr. King suggests that an accurate knowledge of the conditions which produce spectral changes can only be obtained by the detailed study of each element under every possible condition of temperature, vapour pressure, and electrical excitation, and to this end he has commenced with the line spectrum of copper.

He found that on using a high voltage, but small current, in producing the arc spectrum, the "spark" lines were shown on his photographs, and he attributes this phenomenon to the frequent interruptions of the arc producing electrical conditions similar to those obtaining in the spark discharge. Again, in the spark, he photographed the spectrum of the green luminous vapour outside the direct path of the spark, and found that whilst the air spectrum was almost entirely eliminated, there were very few changes amongst the intensities of the copper lines. As this outer layer would have, presumably, the same electrical conditions as, but a lower temperature than, the spark track, he suggests that the experiment affords strong evidence that the electrical condition, rather than the vapour density or the temperature, is the governing factor in producing the various types of spectra.

Mr. King gives a table of the lines which he has studied, showing the behaviour of each line under the different conditions, and he also describes the experimental methods and the results obtained when the temperature, pressure, &c., were varied (*Astrophysical Journal*, No. 1, vol. xx.).

EPHEMERIS FOR THE RETURN OF ENCKE'S COMET.—A further extract from the ephemeris for the approaching return of Encke's comet, published by MM. Kaminsky and Ocoulitsch in No. 3962 of the *Astronomische Nachrichten*, is given below:—

Ephemeris oh. (M.T. Berlin).

1904	α (app.) h. m. s.	δ (app.) ° ′	log r	log Δ
Sept. 8	1 49 33	+24 59	0·3183	0·1097
,, 12	1 46 38	+25 34	0·3094	0·0828
,, 16	1 43 6	+26 8	0·3002	0·0551
,, 20	1 38 20	+26 41	0·2906	0·0266
,, 24	1 32 21	+27 12	0·2806	9·9974
,, 28	1 25 1	+27 40	0·2702	9·9677
Oct. 2	1 16 12	+28 3	0·2593	9·9377

According to the above, the comet should apparently be situated about half-way between β Arietis and α Triangulum on September 18, and, travelling thence in a W.N.W. direction, it should arrive very near to υ Piscium on October 2.

SUPPOSED RELATION BETWEEN SUN-SPOT MINIMA AND MAXIMA INTENSITIES.—From an analysis of Wolfer's relative numbers, M. Angot believes that he has discovered a connection between the intensity of a sun-spot minimum and the intensity of the succeeding maximum.

According to a table prepared by him, and published in No. 4 (1904) of the *Comptes rendus*, a minimum during which the number of spots is very small is followed by a maximum in which the spots are correspondingly few.

In accordance with this theory, the maximum now approaching should be a feeble one, the relative number for the spots not exceeding 70 or 80, because the relative number for the past minimum was very small, viz. about 3·0.

EPHEMERIS FOR COMET TEMPEL$_2$.—A continuation of the ephemeris for Tempel's second comet during the approaching apparition, taken from the daily ephemeris published by M. Coniel in No. 3962 of the *Astronomische Nachrichten*, is given below:—

Ephemeris 12h. (M.T. Paris).

1904	α app. h. m. s.	δ app. ° ′	log. Δ	$1 : r^2\Delta^2$
Sept. 7	15 7 9	−10 12	0·2361	0·142
,, 11	15 16 36	−11 22	0·2380	0·143
,, 15	15 26 26	−12 30	0·2398	0·145
,, 19	15 36 39	−13 38	0·2416	0·147
,, 23	15 47 15	−14 44	0·2433	0·149
,, 27	15 58 14	−15 49	0·2450	0·151
Oct. 1	16 9 37	−16 53	0·2467	0·152
,, 5	16 21 22	−17 53	0·2484	0·154

The comet is due at perihelion early in November. On September 9 it should apparently be between one and two degrees south of β Libræ, and on October 2 about one degree south of φ Ophiuchi. As this comet is likely to be only a faint object during this apparition, it may be a difficult one for observers in this country.

DIRECTION OF THE SUN'S PROPER MOTION.—In No. 3961 of the *Astronomische Nachrichten* Prof. Kobold discusses the proper motions of 144 stars chiefly taken from the catalogues of Porter and Bradley.

From the discussion he deduces the position of the anti-apex of the Sun's-Way, and finds it to be a point near to α Argus having as its coordinates

$$A = 159°{\cdot}6, \quad D = -54°{\cdot}7.$$

As a general result, he states that the stars, of which the motions are perpendicular to the parallactic motion, are situated in preponderating numbers in a zone which passes through the apex and anti-apex, and runs perpendicular to the plane of the Milky Way, the point towards which they appear to be travelling being situated near to α Argus.

THE BRITISH ASSOCIATION.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY PROF. C. S. SHERRINGTON, M.A., D.Sc., M.D., LL.D., F.R.S., PRESIDENT OF THE SECTION.

Correlation of Reflexes and the Principle of the Common Path.

It has been lightly said that this Association meets to cultivate less muses than amusements. The two are compatible, and here happily the muses not merely nine, but ten; for we surely include among the muses "Physiologia." Here in Cambridge our muse admits frankly that a mistake has been made about Parnassus—it is not a mountain but a flat place, almost fenny, once worried by mosquitoes, and now immune from all worries.

Perhaps the confusion between Parnassus and a mountain was due to the Gog-Magog hills. Those hills our muse has haunted and still haunts. She has votaries there; among them one who instituted her worship in this place, a teacher whose powerful appeal attracted disciples from all sides, one whose enthusiasm was, moreover, never narrowed to a single science alone, but floods all biology. With Cambridge and Physiology the name of Sir Michael Foster rises to the lips as an indissoluble sequence. So it will ever be; and it must give him pleasure, as it gives us, to have for his successor here one of his first pupils, one associated far and wide with that which Physiology treasures as always golden, the discovery of imperishable facts.

When this Section last met, two years ago, its President, Prof. Halliburton, reviewed for us the existing position of chemical physiology. We cannot from the nervous system draw themes of such general attractiveness as the new biochemistry, with its startling reactions, its varied hypotheses, its *toxophores, haptophores, amboceptors*, and other fairy-like agents.

Physiology studies the nervous system from three main points of view. One of these regards its processes of nutrition. Nerve-cells, as all cells, lead individual lives, breathe, dispense their own stores of energy, repair their own substantial waste, are, in short, living units, each with a nutrition more or less centred in itself. The problems of nutrition of the nerve-cell and of the nervous system, though partly special to this specially differentiated form of cell life, are, on the whole, accessible to the same methods as is nutrition in other cells and in the body as a whole.

But beside the essential functions common to all living cells, the cells of the nervous system present certain which are specialised. Among properties of living matter, one by its high development in the nerve-cell may be said to characterise it. I mean the cell's transmission of excitement spatially along itself and thence to other cells. This "conductivity" is the specific physiological property of nerve-cells wherever they exist. Its intimate nature is, therefore, a problem coextensive with the existence of nerve-cells, and enters as a factor into every question concerning the specific reactions of the nervous system.

Thirdly, physiology seeks in the nervous system how by its "conductivity" the separate units of an animal body are welded into a single whole, and from a mere collection of organs there is constructed an individual animal.

This third line of inquiry, though greatly needing more data from the second and the first, must in the meantime go forward of itself. It is at present busied with many questions that seem special—hence its work is generally catalogued as Special Physiology. But it includes general problems. In the time before us I would venture to put before you one of these.

When we regard the nervous system as to this, which I would term its *integrative* function, we can distinguish two main types of system according to the mode of union of the conductors—(i.) the *nerve-net* system, such as met in Medusa and in the walls of viscera, and (ii.) the *synaptic* system, such as the cerebro-spinal system of Arthropods and Vertebrates. In the integrative function of the nervous system the unit mechanism is the *reflex*. The chain of conduction in the reflex is a nervous arc, running from a receptor organ to an effector organ, *e.g.* from a sense-organ to a limb-muscle. We may still, I think, conveniently accept the morphological units termed neurones as units of construction of the reflex arc. It may be that these neurones are in some cases not unicellular but pluricellular. That question need not detain us now. Accepting the neurone as the unit of structure of the reflex chain, the characteristic of the synaptic system is that the chain consists of neurones jointed together in such a way that conduction along the chain seems possible in one direction only. These junctions of the neurones are conveniently termed synapses. The irreversible direction of the conductivity along the neurone chain is probably referable to its synapses. This irreciprocity of conduction especially distinguishes the synaptic nervous system from the nerve-net system.

The first link of each reflex chain is a neurone which starts in a receptor organ, *e.g.* a sense-organ. A receptive field, *e.g.* an area of skin, is always analysable into receptive points, and the initial nerve-path in every reflex arc starts from a receptive point or points. A single receptive point may play reflexly upon quite a number of different effector organs. It may be connected through its reflex path with many muscles and glands in various parts. Yet all its reflex arcs spring from the one single shank, so to say; that is, from the one afferent neurone that conducts from the receptive point at the periphery into the central nervous organ. This neurone dips at its deep end into the great central nervous organ, the cord or brain. There it enters a vast network of conductive paths. In this network it forms manifold connections. So numerous are its potential connections there, that, as shown by the general convulsions induced under strychnia-poisoning, its impulses can discharge practically every muscle and effector organ in the body. Yet in normal circumstances the impulses conducted by it to this central network do not irradiate there in all directions. Though their spread over the conducting network does, as judged by the effects, increase with increase of stimulation of the entrant path, the irradiation remains limited to certain lines. Under weak stimulation of the entrant path these lines are sparse. The conductive network affords, therefore, to any given path entering it some communications that are easier than others. This canalisation of the network in certain directions from each entrant point is sometimes expressed, borrowing electrical terminology, by saying that the conductive network from any given point offers less resistance along certain circuits than along others. This recognises the fact that the conducting paths in the great central organ are arranged in a particular pattern. The pattern of arrangement of the conductive network of the central organ reveals somewhat of the integrative function of the nervous system. It tells us what organs work together in time. The impulses are led to this and that effector organ, gland or muscle, in accordance with the pattern. The success achieved in the unravelling of the conductive patterns of the brain and cord is shown by the diagrams furnished by the works of such investigators as Edinger, Exner, Flechsig, van Gehuchten, v. Lenhossek, v. Monakow, Ramon, and Schäfer. Knowledge of this kind stands high among the neurological advances of our time.

But we must not be blind to its limitations. The achievement may, though more difficult, be likened to tracing the distribution of blood-vessels after Harvey's discovery gave them meaning, but before the vasomotor mechanism was discovered. The blood-vessels of an organ may be turgid at one time, constricted almost to obliteration at another. With the conductive network of the nervous system the temporal changes are even greater, for they extend to absolute withdrawal of nervous influence. Our schemata of the pattern of the great central organ take no account of temporal data. But the pattern of the web of conductors is not really immutable. Functionally its details change from moment to moment. In any active part it is a web that shifts from one pattern to another, from a first to a second, from a second to a third, then back perhaps to the first, and then to a fourth, and so on backwards and forwards. As a tap to a kaleidoscope, so a new stimulus that strikes the central organ causes it to assume a partially new pattern. The pattern in general remains, but locally the patterns are in constant flux of back and forward change. These time-changes offer, I venture to think, a study important for understanding the integrative function of the nervous system.

If we regard the nervous system of any higher organism from the broad point of view, a salient feature in its architecture is the following. At the commencement of every reflex arc is a receptive neurone, extending from the receptive surface to the central nervous organ. That neurone forms the sole avenue which impulses generated at its receptive point can use whithersoever may be their distant destination. That neurone is therefore a path exclusive to the impulses generated at its own receptive points, and other receptive points than its own cannot employ it.

But at the termination of every reflex arc we find a final neurone, the ultimate conductive link to an effector organ, gland or muscle. This last link in the chain, *e.g.* the motor neurone, differs obviously in one important respect from the first link of the chain. It does not subserve exclusively impulses generated at one single receptive source alone, but receives impulses from many receptive sources situate in many and various regions of the body. It is the sole path which all impulses, no matter whence they come, must travel if they would reach the muscle-fibres which it joins. Therefore, while the receptive neurone forms a private path exclusive for impulses of one source only, the final or efferent neurone is, so to say, a public path, *common* to impulses arising at any of many sources in a variety of receptive regions of the body. The same effector organ stands in reflex connection not only with many individual receptive points, but even with many various receptive *fields*. Reflex arcs arising in manifold sense-organs can pour their influence into one and the same muscle. A limb-muscle is the *terminus ad quem* of nervous arcs arising not only in the right eye but in the left, not only in the eyes but in the organs of smell and hearing; not only in these, but in the geotropic labyrinth, in the skin, and in the muscles and joints of the limb itself and of the other limbs as well. Its motor nerve is a path common to all these.

Reflex arcs show therefore the general feature that the initial neurone is a private path exclusive for a single receptive point; and that finally the arcs embouch into a path leading to an effector organ, and that this final path is common to all receptive points wheresoever they may lie in the body, so long as they have any connection at all with the effector organ in question. Before finally converging upon the motor neurone arcs usually converge to some degree by their private paths embouching upon internuncial paths common in various degree to groups of private paths. The terminal path may, to distinguish it from internuncial common paths, be called *the final common path*. The motor nerve to a muscle is a collection of such final common paths.

Certain results flow from this arrangement. One seems the preclusion of qualitative differences between nerve-impulses arising in different afferent nerves. If two conductors have a tract in common, there can hardly be qualitative difference between their modes of conduction.

A second result is that each receptor being dependent for communication with its effector organ upon a path not exclusively its own but common to it with certain other receptors, that nexus necessitates successive and not simultaneous use of the common path by various receptors using it to different effect.

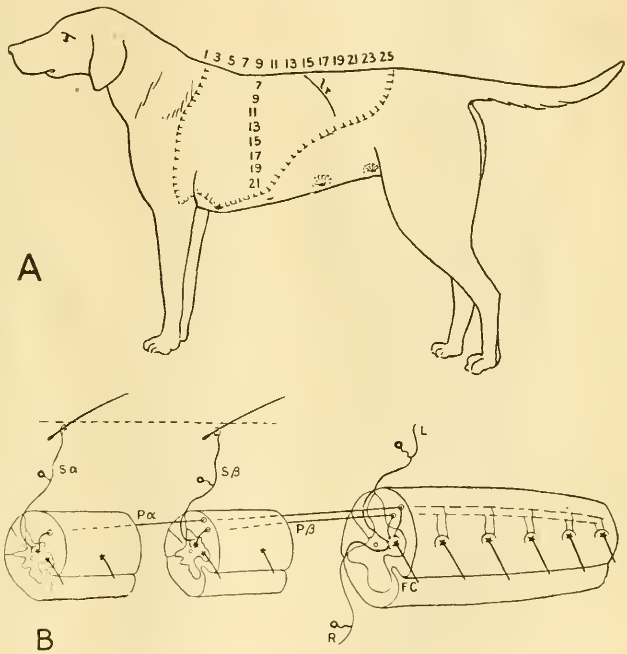

FIG. 1.—The Scratch Reflex. A.—The "receptive field," as revealed after low cervical transection, a saddle-shaped area of dorsal skin, whence the scratch reflex of the left hind limb can be evoked. *lr* marks the position of the last rib. B.—Diagram of the spinal arcs involved. L, receptive or afferent nerve-path from the left foot; R, receptive nerve-path from the opposite foot; Sα, Sβ, receptive nerve-paths from hairs in the dorsal skin of the left side; FC, the final common path, in this case the motor neurone to a flexor muscle of the hip; Pα, Pβ, proprio-spinal neurones.

Let us consider this for a moment. Take the primary retinal reflex, which moves the eye so as to bring the fovea to the situation of the stimulating image. From all the receptors in each lateral retinal half rise reflex arcs with a final common path in the nerve of the opposite *rectus lateralis*. Suppose simultaneous stimulation of two of these retinal points, one nearer to, one farther from, the fovea. If the arcs of both points pour their impulses into the final common path together, the effect must be a resultant of the two discharges. If these sum, the shortening of the muscle will be too great and the fovea swing too far for either point. If the resultant be a compromise between the two individual effects, the fovea will come to lie between the two points of stimulation. In both cases the result obtained would be useless for the purposes of either. Were there to occur at the final common path summation of the impulses received from two unlike receptors, there would result in the effector organ an action useless for the purposes of either.

When two stimuli are applied simultaneously which would evoke reflex actions that employ the same final common path in different ways, in my experience one reflex appears without the other. The result is this reflex or that reflex, but not the two together. Excitation of the afferent root of the eighth or seventh cervical nerve of the monkey evokes reflexly in the same individual animal, sometimes flexion at elbow, sometimes extension. If the excitation be preceded by excitation of the first thoracic root, the result is almost always extension; if preceded by excitation of the

sixth cervical root, it is almost always flexion. Yet although the same root may thus be made to evoke reflex action of the flexors or of the extensors, I have never seen it evoke contrac-

FIG. 2.—Interference between the reflex action of the left hip flexor, FC, caused by the nervous arc from the left foot (L, Fig. 1 B) and the scratch reflex. The stimulation of the dorsal skin (Fig. 1 A) inducing the scratch reflex began at the beginning of the notch in the signal line S, and continued throughout the period of that notch. Later, for the period marked by the notch in the signal line L the stimulation of the foot was made. This latter stimulation interrupts the clonic scratch reflex in the manner shown. The time is registered above in fifths of seconds. The tracing reads from left to right. It is noteworthy that the interruption of the scratch reflex by the foot reflex is not established directly the foot stimulus begins, and that it outlasts for a short time the application of the foot stimulus.

tion in both flexors and extensors in the same reflex response. Of the two reflexes on extensors and flexors respectively, either the one or the other results, but not the two together.

Good opportunity for study of this correlation between reflexes is given in the "scratch reflex." When the spinal cord has been transected in the neck, this reflex in a few months becomes prominent. Stimuli applied within a large saddle-shaped field of skin (Fig. 1 A) excite a scratching movement of the leg. The movement is rhythmic flexion at hip, knee, and ankle. It has a frequency of about four per second. The stimuli provocative of it are mechanical, such as rubbing the skin, or pulling lightly on a hair. The nerve-endings which generate the reflex lie in the surface layer of the skin, about the roots of the hairs. A convenient way of exciting these is by feeble faradisation. A broad diffuse electrode is applied to some indifferent part of the surface elsewhere, and a stigmatic pole is brought to some point in the saddle-shaped area of dorsal skin. This pole is formed by a minute needle with fine wire attached; it is set lightly, so that its point just lies among the hair-bulbs.

Prominent among the muscles active in this reflex are the flexors of the hip. If we record their rhythmic contraction we obtain tracings as in Figs. 2, 3, 4. A series of brief contractions succeed one another at a certain rate, the frequency of which is independent of that of the stimulation. The contractions are presumably brief tetani. The stimulus to the hair-bulbs of the shoulder throws into action a lumbar spinal centre, innervating the hip-flexor much as the bulbar respiratory centre drives the spinal *phrenicus* centre. In the case of the respiratory muscle the frequency of the rhythm is, however, much less.

This reflex is unilateral: stimulation of the left shoulder evokes scratching by the left leg, not by the right. Search in the spinal cord for the path of the reflex demonstrates that a lesion breaking through one lateral half of the cord anywhere between shoulder and leg abolishes the ability of the skin of that shoulder to excite the scratch reflex, but leaves intact the reflex of the opposite shoulder.

In the lateral half of the spinal cord which the reflex path descends, severance of the dorsal column does not interfere with the reflex; nor does severance of the ventral and the dorsal columns together of that side; no more does severance of the grey matter in addition. But severance of the lateral part of the lateral column itself permanently abolishes the conduction of the reflex; and it does so even if all the other parts of the cord remain intact. The path of the reflex therefore descends the lateral part of the lateral column. I enter into these details because they help toward the construction of the reflex arc involved. For in the lateral part of the lateral column one has proved by "*successive degeneration*" that *long* fibres exist directly connecting the spinal segments of the shoulder with the spinal segments containing the motor neurones for the flexor muscles of the hip, and knee, and ankle. The course of these long fibres can be traced and their number

counted. We thus arrive at the following reflex chain for the scratch reflex: (i.) The receptive neurone (Fig. 1 B, sα), from the skin to the spinal grey matter of the corresponding spinal segment in the shoulder. This is the exclusive or private path of the arc. (ii.) The long descending propriospinal neurone (Fig. 1 B, Pα), from the shoulder segment to the grey matter of leg segments. (iii.) The motor neurone (Fig. 1 B, FC), from the spinal segment of the leg to the flexor muscles. This last is the *final common path.* The chain thus consists of three neurones. It enters the grey matter twice, that is, it has two neuronic junctions, two synapses. It is a *disynaptic* arc.

Now if, while stimulation of the skin of the shoulder is evoking the scratch reflex, the skin of the hind foot is stimulated (Fig. 2), the scratching is arrested. Stimulation of the skin of the hind foot by any of various stimuli that have the character of threatening the part with damage causes the leg to be flexed, drawing the foot up. This reflex response to noxious stimuli of the foot is one of great potency. The drawing up of the foot is effected by strong tonic contraction of the flexors of ankle, knee, and hip. In this reaction the reflex arc is (i.) the receptive neurone (Fig. 1 B, L) (nociceptive) from the foot to the spinal segment, (ii.) perhaps a short intraspinal neurone, and (iii.) the motor neurone (Fig. 1 B, FC) to the flexor muscle, *e.g.* of hip. Here, therefore, we have an arc which embouches into the same *final common path* as sα. The motor neurone FC is a path common to it and to the scratch reflex arcs; both arcs employ the same effector organ, a hip flexor. And, as you see, a condition for one reflex is the absence of the other.

The channels for both reflexes finally embouch upon the same common path. The flexor effect specific to each differs strikingly in the two cases. In the scratch reflex the flexor effect is an intermittent contraction of the muscle, in the nociceptive reflex it is steady and maintained. The accompanying tracing (Fig. 2) shows the result of conflict between the two reflexes. The one reflex displaces the other from the common path. There is no compromise. The scratch reflex is set aside by that of the nociceptive arc from the foot. The stimulation which previously sufficed to evoke the scratch reflex is no longer effective, though it is continued all the time. But when the stimulation of the foot is discontinued the scratch reflex returns. In that respect, although there is no enforced inactivity, there is inhibition. There is interference between the two reflexes, and the one is inhibited by the other. Though there is no cessation of activity in the motor neurone, one form of activity that was being impressed upon it is cut out and another takes its place. A stimulation of the foot too weak to cause more than a minimal reflex movement will often suffice to completely interrupt or cut short, or prevent onset of, the scratch reflex.

Suppose, again, during the scratch reflex, stimuli applied to the foot, not of the scratching but of the opposite side (Fig. 1 B, R). Stimulation (nociceptive) of the foot causes flexion of its own leg and extension of the opposite. In numerous instances reflex contraction of one set of muscles is accompanied by reflex relaxation of their antagonists.

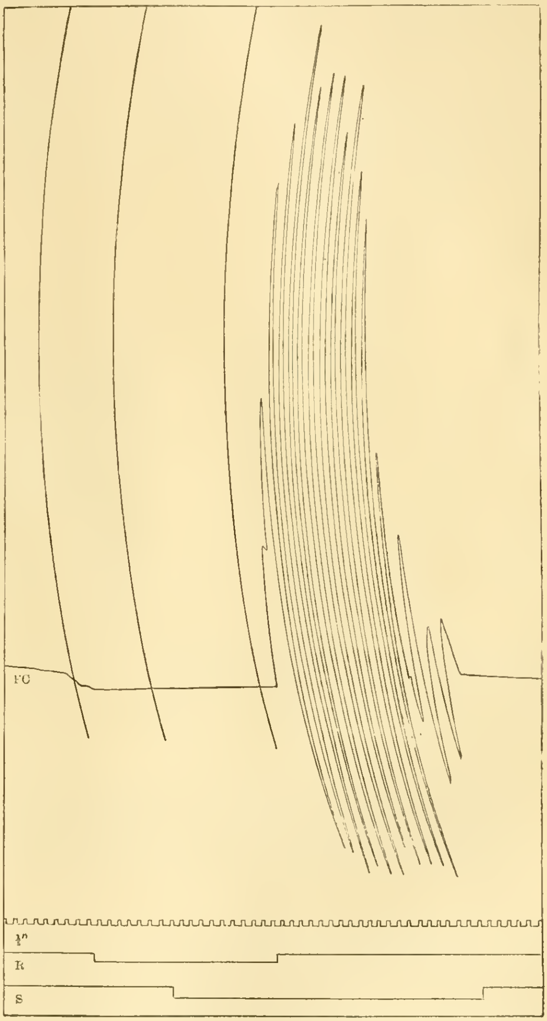

FIG. 3.—Interference of the reflex from the skin of the opposite foot with the scratch reflex, FC, the flexor muscle of the left hip (Fig. 1 B, FC) R, the signal line the notch in which marks the beginning, continuance, and conclusion of a skin stimulation of the right foot (Fig. B, R). S, signal line similarly marking the period of stimulation of the skin of the left shoulder (Fig. 1 B, Sα). The ability of stimulus S to produce the scratch reflex takes effect only on concluding stimulus R; that is, S obtains connection with the *final common path* (the motor neurone of the flexor muscle) only on R's relinquishing it. Stimulus R, while excluding S from FC, causes slight contraction of FC's antagonist, and coincident slight relaxation of FC itself. Time in fifths of seconds. Read from left to right.

The antagonistic muscle is thrown out of action. If, when the left leg is executing the scratch reflex, the right foot is stimulated, the scratching, involving as it does the left

leg's flexors, is cut short concomitantly with or preparatory to the entrance into contraction of their antagonists, the left extensors. Fig. 3 shows a record of this. This inhibition of the flexor scratching movement occurs sometimes when the contraction of the extensors is minimal or hardly perceptible (Fig. 3). As before, the inhibition may temporarily interrupt a reflex or may delay its onset, or simply cut it short, the result depending on the time relations of the applications of the stimuli to the conflicting arcs.

It is obvious from this that the final common path, FC, to the flexor muscle can be controlled by, in addition to the before-mentioned arcs, others that actuate the extensor muscles, for it can be thrown out of action by them. The final path, FC, is therefore common to the reflex arcs, not only from the same-side foot (Fig. 1 B, L) and shoulder skin (Fig. 1 B, $s\alpha$, $s\beta$), but also to arcs from the opposite foot (Fig. 1 B, R), in the sense that it is in the grasp of all of them. In this last case we have a conflict for the mastery of a common path, not, as in the previous instance, between two arcs both of which use the path in a pressor manner although differently, but between two arcs that, though both of them control the path, control it differently, one in a pressor manner heightening its activity, the other in a depressor manner lowering or suppressing its activity.

I said that the scratch reflex is unilateral. If the right shoulder be stimulated, the right hind-leg scratches; if the left shoulder be stimulated, the left hind-leg scratches. If both shoulders be stimulated at the same time, one or the other leg scratches, but not the two together. The one reflex that takes place prevents the occurrence of the other. The reason is, that although the scratch reflex appears unilateral it is not strictly so. Suppose the left shoulder stimulated. The left leg then scratches. If the right leg is then examined it is found to present slight, steady extension with some abduction. This extension of the leg which accompanies the scratching movement of the opposite leg contributes to support the animal on three legs while it scratches with the fourth.

Suppose stimulation at the left shoulder evoking the scratching movement of the left leg, and the right shoulder then appropriately and strongly stimulated. This latter stimulus often inhibits the scratching movement in the opposite leg and starts it in its own. In other words, the stimulus at the right shoulder not only sets the flexor muscles of the leg of its own side into scratching action, but it inhibits the flexor muscles of the opposite leg. It throws into contraction the extensor muscles of that leg. In the previous example there was a similar co-ordination. The motor nerve to the flexor muscle is therefore under the control not only of the arcs of the scratch reflex from the homonymous shoulder, but of those from the crossed shoulder as well. But in regard to their influence upon this final common path, the arcs from the homonymous shoulder and the opposite shoulder are opposed. The influence of the latter depresses or suppresses activity in the common path.

Experiments by Verworn disallow any view that this kind of depression has its field in the motor nerve itself. Many circumstances connect it with the place where the converging neurones come together in the grey matter at commencement of the common path. The field of competition between the rival arcs seems to lie in the grey matter, where they impinge together upon the final or motor neurone. That is equivalent to saying that the essential seat of the phenomenon is the synapse between the motor neurone and the axone-terminals of the penultimate neurones that converge upon it. There some of these arcs drive the final path into one kind of action, others drive it into a different kind of action, and others again preclude it from being activated by the rest.

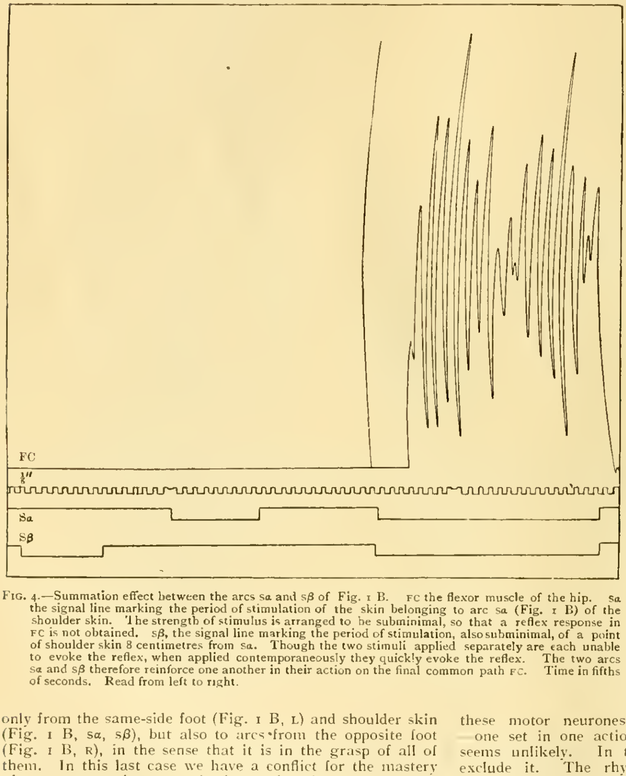

FIG. 4.—Summation effect between the arcs $s\alpha$ and $s\beta$ of Fig. 1 B. FC the flexor muscle of the hip. $s\alpha$ the signal line marking the period of stimulation of the skin belonging to arc $s\alpha$ (Fig. 1 B) of the shoulder skin. The strength of stimulus is arranged to be subminimal, so that a reflex response in FC is not obtained. $s\beta$, the signal line marking the period of stimulation, also subminimal, of a point of shoulder skin 8 centimetres from $s\alpha$. Though the two stimuli applied separately are each unable to evoke the reflex, when applied contemporaneously they quickly evoke the reflex. The two arcs $s\alpha$ and $s\beta$ therefore reinforce one another in their action on the final common path FC. Time in fifths of seconds. Read from left to right.

My diagram (Fig. 1 B) treats the final common path as if it consisted of a single individual neurone. It is, of course, not so. The single neurone of the diagram stands for several thousands. It may be objected that in the various given actions these motor neurones are implicated in particular sets one set in one action, one set in another. That view seems unlikely. In the scratch reflex, I think we can exclude it. The rhythm of that reflex has the same frequence whether it be excited strongly or feebly: thus, whether the extent of the contractions be great or small they recur with practically the same frequence. That a muscle contracts feebly under feeble stimulation of its nerve may be due in some cases to a fraction only of the nerve-fibres and muscle-fibres of the preparation being then active. But in the scratch reflex the whole group of motor neurones seem to act, even when the grade of contraction exhibited is quite weak. Let the reflex be excited by stimulation of the skin-point $s\alpha$ (Fig. 1 B), and let the stimulus be weak, producing only a feeble reflex. Then let another skin-point, $s\beta$ (Fig. 1 B), be stimulated while $s\alpha$ is being stimulated, and let the stimuli at $s\beta$ be timed so as to fall alternately with those applied at $s\alpha$. Then if the two paths impinge on two different sets of units in the compound group of

motor neurones, evidence of two rhythms should appear, for the muscle-fibres can respond to a much quicker rhythm than the four per second. But in result the rhythm remains unquickened and unaltered. Either sα prevents the access of sβ to the motor nerones of FC, or sα's reflex having impressed its own tempo on the neurones of FC, the stimuli from sβ fall within a refractory period of the neuronic apparatus. On either supposition, sα and sβ must play upon the same individual neurones of the final path. A like result is given by all other points I have tried in the receptive field of the scratch reflex. Again, in the inhibitions previously mentioned, when there occurs the tonic contraction or the relaxation of the flexor we find no intermittent contraction of the scratch reflex grafted on them, as would be the case were that intermittent contraction still involving some part of the whole muscle. These various reflexes seem to treat the final common path as a unit. The diagram therefore seems justified in representing the common path, FC, as a unit.

We have no time to multiply further now the categories of reflexes playing upon the final common path FC. I might cite the deep reflex arc which arises in the muscles themselves and is answerable for the mild reflex tonus that even in the spinal animal maintains the tonic posture of the limb. Or, instead of having taken arcs that arise in the skin of the foot, we might have taken others arising above the knee, and traced a reflex influence different from the arcs arising in the foot, but yet playing upon the same final common path; or we might have taken arcs from the skin of the tail, that inhibit the reflex; or from the fore feet, or the ears.

There is, however, one instance of action upon this final common path FC which I would quote. Suppose, while the scratch reflex is being elicited from a point at the shoulder, a second point, say 10 centimetres distant, but also in the dorsal field of skin, is stimulated. The stimulation at this second point favours the reaction from the first point. This is well seen when the stimulus at each point is of subminimal intensity. The two stimuli, though each unable separately to invoke the reflex, do so when applied both together (Fig. 4). This is not due to overlapping spread of the feeble currents about the stigmatic poles of the two circuits used. Mere cocainisation of either of the two skin-points annuls it. Moreover, it occurs when purely mechanical stimuli are used. It is evident that the arcs from the two points, *e.g.* sα and sβ (Fig. 1 B), have such a mutual relation that reaction of one reinforces reaction of the other, as judged by the effect upon the *final common path* FC. Such mutual reinforcement is usual between reflexes of identical species evoked from one and the same receptive field, *e.g.* the nociceptive of the foot.

Not for all the arcs arising in the receptive field of the scratch reflex can, in my experience, this mutual reinforcement be demonstrated. There seems a gradual fall in reinforcing power as the distance between the receptors of the arcs increases. In this connection the following point is noteworthy. The scratch reflex carries the foot broadly toward the place of stimulation. In the spinal dog the reflex does not succeed in bringing the foot actually to the irritated point, yet when the irritation is far forward the foot is carried further forward, and when the irritation is far back the foot is carried further back. A scratch reflex evoked by a stimulus applied far back and high up in the dorsal skin is therefore not wholly like a scratch reflex evoked from far forward and low down. Now, the mutual reinforcement between the scratch reflex arcs in their action on the final common path FC seems greater the greater the likeness between the reflex actions they initiate. The coalition between the reflexes gradually decreases as the interval between their receptive points at the skin surface becomes wider. Whether coalition fades into mere indifference, or passes over into antagonism, my observations as yet do not say. But there are various receptive regions of the body surface that do, in the spinal dog, appear indifferent for the scratch reflex. Were it not that the nervous system is perforce mutilated in the "spinal" animal, the number of these indifferent arcs might be fewer. In presence of the arcs of the great projicient receptors and the brain there can be few receptive points in the body the activities of which are totally indifferent one to another. Correlation of the activities of arcs from receptive points widely apart is the crowning contribution of the brain toward the nervous integration of the individual.

In the case before us, then, the final common path—the motor neurone—to the hip flexor muscle is played upon by various categories of reflex spinal arcs. Of those mentioned, one category (i.), the nociceptive from the leg itself, induces strong, steady contraction in the muscle. A second (ii.), the scalptor or scratching from the dorsal skin, induces rhythmic contraction in the muscle. A third (iii.), from the deep structures of the limb itself, induces the mild enduring contraction known as spinal tonus. A fourth (iv.), *e.g.* the nociceptive from the opposite foot, depresses the activity of the muscle probably by excluding from it the activity of the other arcs which would excite the final path, the motor neurone. And there are many more we could trace from various regions of the body; also, pyramidal and other influences from brain for which our final path is likewise common. The arcs *within* one category may reinforce each other's action on the common path, but those in separate categories are generally correlated in their action on their final common path in such a way as to antagonise one another. They are rivals for possession of their final common path, rivals as retinal points may be rivals for possession of the visual sensorium.

The extent to which in the nervous system this competition for possession of the common path obtains is very great. The multiplicity of the conflict seems extreme. The afferent fibres—that is, private paths—entering the central organ are much more numerous than are the final common paths. We owe to Donaldson and his pupils enumerations which show that the afferent fibres entering the human spinal cord three times outnumber the efferent which leave it. Add the cranial nerves and the so-called optic nerves, and we may take the afferent fibres to be five times the greater. The receptor system bears therefore to the efferent paths a relation like the wide ingress of a funnel to its narrow egress. The simile is bettered by supposing that within the general systemic funnel the conducting paths of each receptor may be represented as a funnel inverted, so that its wider end is more or less co-extensive with the whole plane of emergence of the final common paths. All these private paths converge in the nervous system to the great central organ, the spinal cord and brain, whence on the other hand all the final common paths irradiate. This central organ is, to return to our earlier metaphor, a vast network the lines of which follow a certain pattern. But, as we see from the instances cited—more could be given abundantly, had we time—the pattern is unstable, the details of connection shift from moment to moment. We might compare the central organ with a telephone exchange, where from moment to moment the connections between starting and end points are changed to suit passing requirements. In order to realise the exchange at work, one has to add to its purely spatial plan the temporal datum that within certain limits the connections of the lines shift to and fro. The connections of any entrant path not only offer different degrees of resistance, but their resistances, both absolutely and relatively, vary from occasion to occasion. It is not merely that general conditions of nutrition, of blood-supply, &c., affect these resistances. The functional conductive activity of the nervous organ itself produces from moment to moment the temporary opening of some connections and the temporary closing of others. A good example is the "reciprocal innervation" of antagonistic muscles—when one muscle of the antagonistic couple is thrown into action the other is thrown out of action. This is only a widely spread special case of a general principle. The general principle is the mutual interaction of arcs which embouch upon one and the same common path. Unlike arcs have successive use, but not simultaneous use of the common path. Like arcs mutually reinforce each other in their action on the common path. Expressed teleologically, the common path, although economically subservient for various purposes, is yet used only for one purpose at a time.

Thus the reaction initiated by one receptor while in progress excludes in various directions the reactions of other receptors. In this way the motor paths at any moment accord in a united pattern for harmonious synergy, co-operating for one effect. In the case of simple antagonistic muscles, and in the instances of simple spinal reflex arcs, the shifts of pattern of the conductive network from occasion

to occasion are but of small extent. The co-ordination covers one limb or a pair of limbs. But the same principle extended to the reactions of the great arcs arising in the projicient receptor organs of the head, *e.g.* the eye, that deal with wide tracts of musculature as a whole, involves much further-reaching shift of the conductive pattern. The singleness of action from moment to moment thus assured is a keystone in the construction of the individual whose unity it is the specific office of the nervous system to perfect. Releasing forces acting on the brain from moment to moment shut out from activity whole regions of the nervous system, as they conversely call vast other regions into play. The interference of unlike arcs and the reinforcement of like arcs seem to lie at the very root of the great psychical process of "attention." I will not trench on psychological aspects of the problem.

I have urged that the struggle between dissimilar arcs for mastery over their final common path takes place in the *synaptic field* at origin of the final neurones. Mutual reinforcement by similar arcs seems also referable to the same synaptic field. As to the nature of the physiological processes involved, little, it appears to me, can be said. The final common path seems an instrument more or less passive in the hands of the various arcs that use it. Thus in the scratch reflex one arc can impress one rhythm on it, another another. And in "fatigue" FC reveals, though it does not share, the failure of force of the tired arc playing on it. In regard to the reciprocal innervation of antagonistic muscles W. MacDougall has offered a suggestion of great interest, for which he obtains support from various sensual reactions. He suggests that the neurones of an antagonistic pair are so coupled that when one becomes active it drains energy from its fellow. This takes cognisance of the significant fact that central inhibition seems always accompanied by heightened activity at some related spot. Yet at certain times both the antagonists can show high contemporaneous activity (strychnia, some forms of "willed" action). I think, rather, that in some way the terminal of that arc which for the moment dominates the final common path, disconnects that path from all terminals dissimilar from itself.

Whatever be the nature of the physiological process in the conflict between the competing reflexes, the issue of that conflict—namely, the determination of which competing arc shall for the time being reign over the final common path —is largely conditioned by three factors. One of these is the relative intensity of the stimulation of the rival reflexes. An arc strongly stimulated is *caeteris paribus* more likely to capture the common path than one which is excited feebly. In the spinal dog, retraction equally induced in both legs mutually excludes the crossed extension of either side, but if unequally induced allows the crossed extension of the stronger reflex to exclude the weaker reflex altogether. The common path is probably never out of the grasp of some one or other reflex. Thus, in the spinal dog even, with its limb apparently at rest, this is true. The final common path of the extensor of the knee lies, then, in the hands of a tonic reflex arising in the muscle itself. Given a strong skin stimulus, and it passes under the mastery of the reflex arising in the stimulated skin; but when that is over, the tonus arc immediately repossesses it, and for a short time, as shown by the knee-jerk, more strongly than before.

A second main determinant for the issue of the conflict between the rival reflexes is the functional species of those reflexes. Arcs belonging to species of receptors which, considered as sense-organs, provoke strongly affective sensation —*e.g.* pain, sexual feeling &c.—win the final common path with remarkable facility. Such reflexes override and set aside with peculiar potency reflexes belonging to touch organs, muscular sense-organs, &c. As the sensations evoked by these arcs, *e.g.* pains, exclude and dominate concurrent sensations in consciousness, so do the reflexes of these arcs prevail in the competition for possession of the common paths. They seem capable of pre-eminent intensity of action.

A third main factor deciding the conflict between the competing reflexes is "fatigue." An arc under long continuous stimulation of its receptor tends, even when it holds the common path, to retain its hold less well. Other arcs can then more readily dispossess it. A stimulus to a fresh arc has, in virtue of its mere freshness, a better chance of capturing the common path. The common path does not tire. In the scratch reflex under stimulation of sα when the motor discharge becomes slow and irregular from fatigue, it is still perfect for sβ, or L, &c. (Fig. 1 B). This waning of a reflex under long-maintained excitation is one of the many phenomena that pass in physiology under the name "fatigue." Its place of incidence lies at the synapse. It seems a process elaborated and preserved in the selective evolution of the neural machinery. It prevents long continuous possession of a common path by any one reflex of considerable intensity. It favours the receptors taking turn about. It helps to ensure serial variety of reaction. The organism, to be successful in a million-sided environment, must in its reactions be many-sided. Were it not for such so-called "fatigue," an organism might, in regard to its receptivity, develop an eye, or an ear, or a mouth, or a hand or leg, but it would hardly develop the marvellous congeries of all those various sense-organs which it actually does.

But while talking of fatigue in general I forget the fatigue in particular of listeners. The principle I have tried to outline to you has many and wide applications; it seems fruitful for problems of Pathology and Psychology, as well as for those of Physiology. But I keep you too long. Let me sum up. The reflex arcs (of the synaptic system) converge in their course so as to impinge upon links possessed by whole varied groups in common—*common paths*. This arrangement culminates in the convergence of many separately arising arcs upon the efferent-root neurone. This neurone thus forms a final common path for many different reflex arcs and acts. It is responsive in various rhythm and intensity, and is relatively unfatigable. Of the different arcs which use it in common, each can do so exclusively in due succession, but *different* arcs cannot use it simultaneously. There is, therefore, interference between the actions of the arcs possessing the common path, some reflexes excluding others and producing inhibitory phenomena, some reflexes reinforcing others and producing phenomena of "bahnung." Intensity of stimulation, species of reflex, fatigue, and freshness, all these are physiological factors influencing this interaction of the arcs—and under pathological conditions there are many others, *e.g.* "shock," toxins, &c. Hence follows successive interchange of the arcs that dominate one and the same final common path. We commonly hear a muscle—or other effector organ—spoken of as innervated by a certain nerve; it would be more correct as well as more luminous to speak of it as innervated by certain receptors; thus, the hip flexor, now by this piece of skin, now by that, by its own foot, by the opposite fore-foot, by the labyrinth, by its own muscle-spindles, by the eye, by the "motor" cortex, &c. This temporal variability, wanting to the nerve-net system of medusoid and lower visceral life, in the *synaptic* system provides the organism with a mechanism for higher integration. It fits that system to synthesise from a mere collection of tissues and organs an individual animal. The animal mechanism is thus given solidarity by this principle which for each effector organ allows and regulates interchange of the arcs playing upon it, a principle which I would briefly term that of "the interaction of reflexes about their common path."

SECTION K.

BOTANY.

OPENING ADDRESS BY FRANCIS DARWIN, F.R.S., FELLOW OF CHRIST'S COLLEGE, PRESIDENT OF THE SECTION.

On the Perception of the Force of Gravity by Plants.

WHEN I had the honour of addressing this Association at Cardiff as President of the mother-section from which ours has sprung by fission, I spoke of the mechanism of the curvatures commonly known as tropisms. To-day I propose to summarise the evidence—still far from complete—which may help us to form a conception of the mechanism of the stimulus which calls forth one of these movements—namely, geotropism. I have said that the evidence is incomplete, and perhaps I owe you an apology for devoting the time of this Section to an unsolved problem. But the making of theories is the romance of research; and I may say, in the words of Diana of the Crossways, who indeed spoke of romance, "The young who avoid that region escape the title of fool at the cost of a celestial crown." I am prepared for the risk in the hope that in not avoiding

the region of hypothesis I shall at least be able to interest my hearers.

The modern idea of the behaviour of plants to their environment has been the growth of the last twenty-five years, though, as Pfeffer has shown, it was clearly stated in 1824 by Dutrochet, who conceived the movements of plants to be "spontaneous"—*i.e.*, to be executed at the suggestion of changes in the environment, not as the direct and necessary result of such changes. I have been in the habit of expressing the same thought in other words, using the idea of a guide or signal, by the interpretation of which plants are able to make their way successfully through the difficulties of their surroundings. In the existence of the force of gravity we have one of the most striking features of the environment, and in the sensitiveness to gravity which exists in plants we have one of the most widespread cases of a plant reading a signal and directing its growth in relation to its perception. I use the word perception not of course to imply consciousness, but as a convenient form of expression for a form of irritability. It is as though the plant discovered from its sensitiveness to gravity the line of the earth's radius, and then chose a line of growth bearing a certain relation to the vertical line so discovered, either parallel to it or across it at various angles. This, the reaction or reply to the stimulus, is, in my judgment, an adaptive act forced on the species by the struggle for life. This point of view, which, as I regret to think, is not very fashionable, need not trouble us. We are not concerned with why the plant grows up into the air or down into the ground; we are only concerned with the question of how the plant perceives the existence of gravitation. Or, in other words, taking the reaction for granted, what is the nature of the stimulus? If a plant is beaten down by wind or by other causes into a horizontal position, what stimulative change is wrought in the body of the plant by this new posture?

It is conceivable in the case of a stem supported by one end and projecting freely in the air that the unaccustomed state of strain might act as a signal. The tissues on one side (the upper) are stretched, and they are compressed below: this might guide the plant; it might, in fact, have evolved the habit of rapid growth in the compressed side. This is only given as an illustration, for we know that the stimulus does not arise in this way, since such a plant, supported throughout its length, and, therefore, suffering no strain, is geotropically stimulated. The illustration is so far valuable, as it postulates a stimulus produced by weight, and we know from Knight's centrifugal experiment that weight is the governing factor in the conditions. Since we cannot believe that the stimulus arises from the strain as affecting the geotropic organ as a whole, we must seek for weight-effects in the individual cells of which the plant is built. We must, in fact, seek for weight-effects on the ectoplasm[1] of those cells which are sensitive to the stimulus of gravity.

If we imagine a plant consisting of a single apogeotropic cell we shall see that the hydrostatic pressure of the cell-contents might serve as a signal.

As long as the cell is vertical the hydrostatic pressure of the cell-sap upon the ectoplasm at C (Fig. 1) is equal to that at D. But the pressure on the basal wall, B, differs from that at A (the apical wall) by the weight of the column AB. If the plant be forced into the horizontal, the pressure at A and B becomes the same, while the pressure at C no longer equals that at D, but differs by the weight of the column CD. Here undoubtedly is a possible means by which the plant could perceive that it was no longer vertical, and would have the means of distinguishing up from down. So that if it were an apogeotropic plant it would need to develop the instinct of relatively accelerated growth on the side D, on which the pressure is greatest.

What is here roughly sketched is the groundwork of the theory of *graviperception*[2] suggested by Pfeffer[3] and supported by Czapek,[4] which I shall speak of as the radial pressure theory, and to which I shall return later.

[1] See Noll's ingenious reasoning by which he makes it clear that the stationary ectoplasm, not the flowing endoplasm, is the seat of stimulation. Noll (88).

[2] I propose this term in place of *geoaesthesia*, which does not lend itself to the formation of adjectives, or the hybrid word *geoperception*. By not using the form "geo" we avoid any necessary connection with geotropism, and may thus use terms compounded of *gravi* for phenomena other than those of curvature.

[3] Pfeffer (81). [4] Czapek (98), (01).

It is obvious that there is another consideration to be taken into account, namely, that cells do not contain cell-sap only, but various bodies—nucleus, chloroplasts, crystals, &c.—and that these bodies, differing in specific gravity from the cell-sap, will exert pressure on the physically lower or physically higher cell-walls according as they are heavier or lighter than the cell-sap. Here we have the possibility of a sense-organ for verticality. As long as the stem is vertical and the apex upwards the heavy bodies rest on the basal wall, and the plant is not stimulated to curvature; but if placed horizontally, so that the heavy bodies rest on the lateral cell-walls, which are now horizontal, the plant *is* stimulated to curve. This is known as the *statolith* theory.

It seems to me quite certain that the stimulus must originate either in the weight of solid particles or in the weight of the fluid in the cells, or by both these means together. And for this reason. Take the statolith theory first. There undoubtedly are heavy bodies in cells; for instance, certain loose, movable starch-grains. Now, either these starch-grains are specialised to serve the purpose of graviperception or they are not. If they are so specialised, *codit quaestio*; if they are not, there still remains this interesting point of view: the starch-grains fall to the lower end of the cells in which they occur; therefore, shortly before every geotropic curvature which has taken place since movable starch-grains came into existence, there has been a striking change in the position of these heavy cell-contents. Now, if we think of the evolution of geotropism as an adaptive manner of growth we must conceive plants growing vertically upwards and succeeding in life, others not so behaving, and consequently failing.

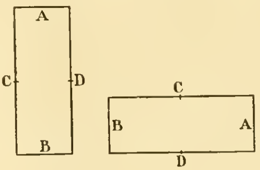

FIG. 1.

There will be a severe struggle tending to pick out those plants which associated certain curvatures with certain preceding changes, and therefore it seems to me that, if movable starch-grains were originally in no way specialised as part of the machinery of graviperception, they would necessarily become an integral part of that machinery, since the act of geotropism would become adherent to or associated with the falling of the starch-grains.

This argument must in fairness be applied to any other physical conditions which constantly precede geotropic curvature; it is therefore not an argument in favour of the statolith theory alone, but equally for the pressure theory, and cannot help us to decide between the two points of view.

Are there any general considerations which can help us to decide for or against the statolith theory? I think there are—namely, (1) analogy with the graviperceptive organs of animals; (2) the specialisation and distribution of the falling bodies in plants.

(1) Berthold[1] (to whom the credit is due[2] of having first suggested that Dehnecke's falling starch-grains might function as originators of geotropic reaction) is perhaps somewhat bold in saying that "the primary effect of gravity" as regards stimulation must depend on the passive sinking of the heavier parts. Noll, too,[3] says that Knight's experiment depends on weight, and not the weight of complete parts of the plant-body; but of weight within the irritable structure. I cannot see that these downright statements are justified on direct evidence, and I accordingly lay some stress on the support of zoological evidence. It

[1] "Protoplasmamechanik," 1886, p. 73. I was directed to this passage by Pfeffer's discussion ("Pflanzenphysiologie," ed. 2, ii., p 641).

[2] Berthold's remarks seem not to have received much notice, and it was not till the publication of Noll's "Heterogene Induction," 1892, that a form of the statolith theory was at all widely recognised as a possible explanation.

[3] "Heterogene Induction," p. 41.

has been conclusively proved by Kreidl's[1] beautiful experiment that in the Crustacean Palæmon the sense of verticality depends on the pressure of heavy bodies on the inside of cavities now known as statocysts, and formerly believed to be organs of hearing. The point of the experiment is that when the normal particles are replaced by fragments of iron the Palæmon reacts towards the attraction of a magnet precisely as it formerly reached towards gravity.

It is unfortunate that Noll's arguments in favour of the existence of a similar mechanism in plants were not at once followed by the demonstration of those easily visible falling bodies, which, in imitation more flattering than accurate, are called *statoliths*, after the bodies in the statocysts of animals. Personally I was convinced by Kreidl, as quoted by Noll, that here was the key to graviperception in plants. But it was not until the simultaneous appearance of Haberlandt's[2] and Němec's[3] papers that my belief became active, and this, I think, was the case with others. The whole incident is an instance of what my father says somewhere about the difficulty of analysing the act of belief. I find it impossible to help believing in the statolith theory, though I own to not being able to give a good account of the faith that is in me. It is a fair question whether the analogy drawn from animals gives any support to the theory for plants. The study of sense-organs in plants dates, I think, in its modern development, at least, from my father's work on root-tips, and on the light-perceiving apices of certain seedlings. And the work on the subject is all part of the wave of investigation into adaptations which followed the publication of the "Origin of Species." It is very appropriate that one of the two authors to whom we owe the practical working out of the statolith theory should also be one of the greatest living authorities on adaptation in plants. Haberlandt's work on sense-organs,[4] especially on the apparatus for the reception of contact stimuli, is applicable to our present case, since he has shown that the organs for intensifying the effect of contact are similar in the two kingdoms. No one supposes that the whisker of a cat and the sensitive papilla of a plant are phylogenetically connected. It is a case of what Ray Lankester called homoplastic resemblance. Necessity is the mother of invention, but invention is not infinitely varied, and the same need has led to similar apparatus in beings which have little more in common than that both are living organisms.

But, whether we are or are not affected in our belief by the general argument from analogy, we cannot neglect the important fact that Kreidl proves the possibility of gravisensitiveness depending on the possession of statoliths. We must add to this a very important consideration—namely, that we know from Nemec's work[5] that an alteration in the position of the statoliths does stimulate the *statocyte*.[6] Such, at least, is, to my mind, the only conclusion to be drawn from the remarkable accumulation of protoplasm which occurs, for instance, on the basal wall of a normally vertical cell when that wall is cleared of statoliths by temporary horizontality. The fact that a visible disturbance in the plasmic contents of the statocyte follows the disturbance of the starch-grains seems to me a valuable contribution to the evidence.

There is one other set of facts of sufficiently general interest to find a place in this section. I mean Haberlandt's result,[7] also independently arrived at by myself, that when a plant is placed horizontally and rapidly shaken up and down in a vertical plane the gravistimulus is increased. This is readily comprehensible on the statolith theory, since we can imagine the starch-grains would give a greater stimulus if made to vibrate on one of the lateral walls, or if forced into the protoplasm, as Haberlandt supposes. I do not see that the difference in the pressure of the cell-sap on the upper and lower walls (*i.e.*, the lateral walls morphologically considered) would be increased. It would, I imagine, be rendered uneven; but the average difference would remain the same. But in the case of the starch-grains an obvious new feature is introduced by exchanging a stationary condition for one of movement. And though I speak with hesitation on such a point, I am inclined to see in Haberlandt's and my own experiments a means of distinguishing between the pressure and statolith theories. Noll,[1] however, considers that the shaking method is not essentially different from that of Knight's experiment, and adds that the result might have been foreseen.

[1] Kreidl (03). [2] Haberlandt (00). [3] Němec (00).
[4] Haberlandt (01). [5] Němec (01, p. 153).
[6] *Id est*, the cells containing statoliths.
[7] Haberlandt (03) and F. Darwin (03).

Distribution.

As far as I know, the development of *statoplasts*[2] has not been made out. Are they at first like ordinary immovable amyloplasts; and, if so, by what precise process do they become movable? Where the two forms of starch are seen in close juxtaposition the difference between them is striking, and it is hardly possible to doubt that these differently situated bodies have different functions. In a seedling *Phalaris canariensis* the apical part has only falling starch-grains, while lower down both forms occur. It suggests a corresponding distribution of graviperception; and, as a fact, the seedling is gravisensitive throughout, but is especially so at the apex. If this is not the meaning of the statoplasts we must find some other. For instance, are the loose starch-grains connected in an unknown way with heliotropic sensitiveness, which often has the same distribution as that of graviperception? Or is the looseness of starch connected in some way with food storage? Is it to allow of starch being closely packed in part of the cell, leaving the rest of the space free?

Again, the most striking general fact about the distribution of falling starch is its presence in the endodermis.[3] If we believe that the endodermis is essentially a tissue of gravisensitive cells we can understand the striking fact that it contains loose starch only as long as the stem is capable of growth curvature.[4] Otherwise the theories of the function of the endoderm, which have never been very satisfactory, have the additional burthen of explaining this last-named fact.

According to Haberlandt (00), some monocotyledons the leaves of which contain no starch have falling grains in the endodermis. Němec (01, p. 24) quotes from Sachs the case of *Allium cepa*, where statoplasts occur in the root-cap, the endoderm, and punctum of the seedling, and not elsewhere. Then we have occurrence of starch in the pulvinus of grasses and not in the rest of the haulm. Viscum is not geotropic, and has no statoplasts. In the holdfast roots of Hedera and Marcgravia there is no starch, and in Hoya, Pothos, and Ficus the starch is not movable, and these roots are not geotropic.[5]

Jost (02) brought forward, as a serious objection to the statolith theory, the fact that tertiary roots possess statoliths, but are not sensitive to gravitation. This objection has been overcome by the discovery[6] that when the primary root is cut off and a secondary assumes its place and manner of growth, the tertiaries springing from it are diageotropic, and thus have at least an occasional use for their statoplasts.

I have shown[7] that the cotyledon of Setaria and Sorghum is the seat of gravi-perception, and it is there that the statoplasts are found.[8] Wiesner (02) was unable to find statoliths in the perianth-segments of *Clivia nobilis*, which are geotropic, nor in those of *Clivia miniata*, which are not geotropic. Here would seem to be a serious objection to the statolith theory, but Němec (04, p. 58), on repeating Wiesner's observations, finds, on the contrary, a confirmation of his own views. For movable starch-grains occur in the perianth of *C. nobilis*, but not in those of *C. miniata*. In the case of roots the distribution of the statoplasts is especially worthy of note. Physiologists have gradually come to believe that my father[9] was right in his view that

[1] Noll (03, p. 131).
[2] I would suggest the word *statoplast* in place of the cumbersome expression *movable starch-grains*.
[3] See Haberlandt (03) for a description of certain special cases of statocyte-tissue, apparently replacing the endodermis.
[4] According to Haberlandt (03, p. 451), it is easy to be deceived in asserting that the endoderm contains no starch. Thus Fischer failed to find it in outgrown stems of some plants which possess it when young. Tondera (03) asserts that in certain Cucurbits the falling starch is only present in the older parts no longer capable of geotropism. But Miss Pertz, who has examined most of the species investigated by Tondera, finds statoplasts in the young parts where he failed to find these. Tondera makes some interesting remarks on the distribution of starch in the Cucurbits harmonising with Heine's storehouse theory. It is obviously difficult in the case of the endoderm to distinguish between starch serving as a reserve and starch serving as part of the mechanism of perception. I see no reason why the second function should not be evolved from the first.
[5] Haberlandt (03, p. 461). [6] Darwin and Pertz (04). [7] F. Darwin (99).
[8] According to Němec they occur to some extent in the hypocotyl of Panicum. [9] C. Darwin ("Power of Movement").

the organ of graviperception is in the tip of the root; and it is there—generally in the root-cap and there only, that statoplasts are found. But these facts do not entirely harmonise with the statolith theory, as I shall show later on in the section devoted to experimental evidence. Here I will only add that the group of statocytes in the root are strongly suggestive of some special function, and those who deny that they form an organ of graviperception must find some other use for them; and this will be no easy task. I must not omit to mention the ingenious experiments of Piccard (04), which prove (if they prove anything) that the root-tip is not the seat of the graviperception, but that this quality is found in even greater perfection in the growing region of the root. But until the whole of the other experimental evidence is proved to be illusory, I must suspend judgment on Piccard's results and treat the question provisionally from our previous standpoint.

The existence of statoliths in regions which have ceased to be capable of ordinary geotropic curvature is at first sight a difficulty. Thus Miss Pertz has found in the pith of the watercress (*Nasturtium officinale*) the most perfect statoplasts, and this in winter, when the capacity for geotropic curvature was probably absent. Again, she has found movable starch in the xylem elements and in the cortex of a number of trees. In this case we must remember that, according to Meischke (99), Jost (01), and Baranetzky (01), woody branches of several years' growth are capable of geotropic curvature. If so, graviperceptive organs must exist. We must remember, too, that in the regeneration of cuttings, Vöchting (78) has shown that gravitation has an influence in certain cases; such cuttings must therefore have organs of graviperception. Or, if this is not granted as necessary, it seems to me conceivable that falling starch-grains, though made use of, and in a certain sense specialised, for graviperception, should nevertheless exist and serve other purposes in the economy of the plant. But this question needs further detailed work.

Lastly, as part of the general question of distribution, it must be clearly pointed out that in a large number of plants, such as Algæ and Fungi, no statoliths are known to exist, though their complete absence has not been proved.[1] Here we must either believe in Noll's minute and hitherto unseen statoliths or in a different mechanism, such as hydrostatic pressure. There is no more impossibility in this state of things than in the presence of statoliths in Palæmon and their absence in higher animals. And I am glad to note that both Pfeffer and Czapek are not disinclined to believe in the possibility of various forms of graviperception.

Experimental Evidence.

A flaw runs through a great part of the experimental evidence, which may be illustrated by an experience of my own. I found[2] that seedlings of Setaria and Sorghum could be nearly deprived of statoplasts by means of a high temperature, and, further, that such destarched plants were markedly less geotropic than normal specimens. Here seemed a proof of the theory; unfortunately, however, it turned out that the plants in question were also rendered less heliotropic. These facts make it impossible to allow Němec's gypsum experiment to be convincing. He caused a loss of starch by enclosing roots in plaster of Paris, and found that they had in great part lost their geotropic power. But he did not discover whether this loss depended on disappearance of part of the sense-organ or on general loss of curving power, though he has since (02) made the interesting observation that roots so treated are capable of hydrotropism. Again, Nemec found in resting seeds of *Vicia Faba* that the statoliths are undeveloped, and that they appear synchronously with the power of geotroping. Would not a similar thing be true of the apheliotropism of Sinapis roots—*i.e.*, might it not be found that they were not heliotropic until the starch appeared?

The same objection must be brought against Haberlandt's otherwise convincing observation[3] that Linum growing out of doors in late autumn or winter is both devoid of statoplasts and incapable of geotropism, and that the power of curvature returns on bringing the plants indoors, when the starch reappears. The full value of these experiments cannot be made clear without going into more detail than is here admissible. They are particularly interesting because, as Haberlandt remarks, so far as they prove the truth of the statolith theory, they also disprove the pressure theory. This may also be said of other experiments mentioned in the present section.

[1] See Němec (*Beihefte Bot. Central.*, B. xvii. 1904, p. 59), where he describes the cases and the occurrence of statoliths in the mosses and liverworts. Giesenhagen (01) has described heavy bodies at the tips of the rhizoids of *Chara* which fall to the physically lower side.

[2] F. Darwin (03).

[3] Haberlandt (03). It seems, however, that the starchless plants had some heliotropic capacity.

We must, I think, object on similar grounds to Nemec's observations, suggestive though they are, on the absence of geotropism in certain individual leaves and roots which, through unknown causes, had no statoliths.[1]

The same must be said of the above-mentioned experiments of Haberlandt, in which geotropism is increased by rapid shaking in a vertical plane. I attempted[2] to avoid this fault in the similar experiments with a tuning-fork made independently, which showed that the effect of vibration in increasing reaction is far greater in the case of geotropism than in heliotropism.

Haberlandt (00) made the interesting observation that plants deprived of their endodermis by means of an operation lose the capacity of geotropism. Here, again, we ought to know how the operation affects sensitiveness other than geotropic; and, as Haberlandt grants, it may perhaps be said that the operation is too serious to allow of the foundation on it of a very convincing argument.

The question how far the statolith theory is applicable to the root is a difficult one. It involves the old and apparently insoluble difficulty of distinguishing between the removal of the tip of the root, considered as a perceptive organ, and the effect of the shock of the operation. The question is, moreover, complicated by contradictory evidence. According to Czapek, cutting off a small part of the root-tip, an operation which does not remove the whole of the statoliths, interferes with geotropism in the same way as does actual amputation.[3]

Němec, on the other hand, finds evidence for the operation depending on the removal of the sense-organ; for according to him the power of geotroping does not return with the appearance of *general* symptoms of recovery, such as cell division and the growth of a callus, but only with the actual reappearance of statocytes.

Němec's most recent experiments[4] are confirmatory of this result. He finds that Lupin roots, from which $\frac{1}{2}$ mm., 1 mm., and $1\frac{1}{2}$ mm. respectively are cut off, behave differently. The $\frac{1}{2}$ mm. lot were clearly geotropic in seven hours, while no curvature occurred in the others. After a further interval of thirteen hours the 1 mm. lot had curved. Microscopic examination showed that statoplasts had appeared in these roots, but not in the $1\frac{1}{2}$ mm. lot, which showed no geotropism. It is particularly interesting that according to Němec the statoplasts appeared in a new growth which was visible as a slight convexity of the cut surface.[5]

An experiment by Nemec with the roots of *V. Faba* must also be mentioned. One millimetre was cut from the tips of each of a number of roots, and they were all placed horizontally. They were examined after fifteen hours, when considerable variety in the result of the operation was evident; some of the roots had bent geotropically, while others were still horizontal. On cutting sections it was found that the geotropic roots had statoplasts, the horizontal ones none. It may of course be said that the result depends on the effect of shock lasting longer in some individual roots, since, as Czapek has well said, the only proof of the disappearance of shock effect is the act of curving. But since the operation was approximately the same in all the roots, it is hard to believe in such a malicious coincidence as that the shock was smaller in all those roots which produced statoplasts. But it may be said that shock prevented both geotropism and statoplast-formation in certain roots.

[1] Němec (01).

[2] F. Darwin (03).

[3] Czapek (02, p. 118).

[4] Němec (04, pp. 46, 53).

[5] This agrees, as Němec says, with Wachtel's (99) results, who found geotropism returning before the whole tip was regenerated.

Czapek (02) quotes the experiment of Brunchorst, who found that a circular cut round the tip, not deep enough to free the terminal part, has the same effect as amputation. On the other hand, Němec[1] states that geotropism persists, if the root-tip is cut half through by two opposite incisions in different planes, so that the whole of the tissues are divided, and yet the tip is not amputated. Thus four out of five bean-roots treated in this way showed distinct geotropism in $5\frac{1}{4}$ hours. This seems to me a striking result, as showing that the shock of the operation is not exclusively the decisive element. Nemec has, moreover, shown that if geotropic curvature has begun on a normal root, a wound interferes with the amount of after-effect, and that the precise nature of the wound is not decisive, and this, as far as it goes, confirms the assumption that two half-cuts would produce as much shock as actual amputation.

Czapek[2] finds that splitting a bean-root longitudinally has the same effect as decapitation. This would mean that decapitation produces its results by shock only, since in a split root there is no removal of the tip. I think I was the first to make use of the splitting of roots in this connection. I wished to show[3] the incorrectness of Wiesner's view—viz., that amputation prevents geotropism by checking growth. In my experiments the split roots were greatly checked in growth, but curved geotropically, behaving in this respect quite differently from amputated specimens.

Another striking bit of evidence on Czapek's side of the question[4] is the fact that Lupin roots from which "$\frac{1}{2}$ mm. of the tip has been removed, and which, therefore, contain no statoliths," show the remarkable homogentisin reaction which he has convincingly proved to be a symptom of graviperception. Czapek adds that the same is true of roots from which 1 mm. has been removed. It seems to me that Němec's reply to this[5] is of value. He finds that the root-cap in Lupin is variable in length, but always longer than $\frac{1}{2}$ mm.; therefore, in the roots from which $\frac{1}{2}$ mm. only was removed there should have been some statocyte tissue remaining. Even after the removal of 1 mm. the root can, according to Nemec, rapidly form statocytes, since the section is in the neighbourhood of the calyptrogen.[6]

Nemec suggests it to be conceivable that differences of pressure in Czapek's sense may give rise to the homogentisin reaction, while the true act of graviperception is confined to the statoplasts. This is no doubt possible, but I confess that, if the homogentisin reaction can occur in root-tips which have no statoliths I should consider it a strong argument in favour of the view that pressure-difference in Czapek's sense supplies the machinery of perception in roots. Czapek also claims that his experiments with bent-glass tubes (Czapek, 95) prove the graviperceptive region of the root not to be confined to the region of statoplasts, since if the root-cap alone is in the vertical branch of the tube, geotropic curvature is not excluded. Němec (04) has attempted a rejoinder to this objection; with what success readers must judge for themselves.

It will be seen that, in my opinion, the balance of evidence is not fatal to the statolith theory. Czapek, who treats the question in a broad and liberal spirit, is by no means inclined to deny that statoliths have a share in graviperception; all he claims to prove is that the statoplasts do not supply the whole of the mechanism. It is not easy for an upholder of the theory to allow this much in the present stage of the controversy. The best way of testing the theory is by comparing the distribution of geotropism with that of statoliths; and if we are to allow, in all cases which are opposed to the statolith theory, that the stimulus depends on pressure differences in Czapek's sense, we deprive ourselves of the best means of proving the truth or falsehood of our theory. Those who uphold the theory must have the courage of their opinions and finally trust to the facts of distribution. But further knowledge is necessary before such a judgment can be made.

[1] Němec (01, p. 19). [2] Czapek, (98, p. 202) and (02, p. 118). [3] F. Darwin (82). [4] Czapek (02, p. 468). [5] Němec (04, p. 53).
[6] He adds that the calyptrogen may in this way have an indirect importance, and Firtsch's belief that this tissue was the essential seat of graviperception may be accounted for.

Centrifugal Force.

Jost[1] objects that plants on a centrifugal machine do not behave as the theory would lead us to expect. Thus he found that certain roots and seedlings showed geotropic curvature, although the statoplasts were scattered through the cell, not spread out on the cell-walls furthest from the axis of rotation. Miss Pertz[2] and I have repeated some of Jost's experiments, and have come to an opposite conclusion. We find that Setaria does not curve with a centrifugal force of less than 0.02 g., and this is about the limit for visible displacement of the starch-grains. As the centrifugal force increases up to 0.04 g. we get slight amounts of curvature and slight amounts of starch displacement. The two phenomena cannot be accurately compared, but so much is clear: that the result of Knight's experiment is not destructive of the statolith theory, but, on the contrary, is roughly in harmony with it.

The result of an intermittent stimulus may seem to some a difficulty. Jost[3] produced geotropic curvature by placing seedlings in the horizontal and vertical positions for alternate periods of $3\frac{1}{2}$ minutes. With alternate periods of 50″ horizontal and 2′ 30″ vertical he sometimes failed to get a geotropic curve, and exposures if less than 50″ always failed. It is commonly said that 15–25 minutes are needed for the starch to fall on to horizontal cell-walls, and it may seem, therefore, that in these experiments neither $3\frac{1}{2}$ minutes nor, *a fortiori*, 50″ could produce a change of position in the statoliths, and that therefore the experiment is destructive to the theory. But this would be a wrong conclusion, for, according to my experience, the falling time of starch is often less than 15 minutes; and even if this were not so there would be no difficulty in understanding the above experiments, for, as Jost allows (*loc. cit.*), and as Němec (02) has also pointed out, the statoplasts may stimulate the cell without the occurrence of any visible displacement; for if the statoplasts do not fall over and spread out on the horizontal walls there must be a column or heap of starch-grains, the height of which equals the width of the cell, resting on the lateral wall of the cell instead of, as in the normal position, a shallower layer pressing on the basal wall. Here we have plain conditions of differentiation between the vertical and horizontal positions.

The same considerations apply to the whole question of what is known as the geotropic presentation time[4]—*i.e.*, the minimal period of horizontality needed to induce a geotropic curvature. It has been said that the presentation time corresponds with the time needed for the statoliths to fall on to the horizontal walls of the sensitive cells. It seems to me that we hardly have knowledge enough to be certain of this coincidence, and since, as above pointed out, the statoliths may begin to stimulate before they are visibly displaced, the question is not one of much interest or deserving of special inquiry.

Theoretical.

Elfving's[5] well-known experiment with grass haulms shows that (in this instance) the action of the klinostat depends, not on the prevention of all graviperception, but on the equal distribution of stimulus.[6] But other plants react differently—that is to say, they do not exhibit increased rectilinear growth on the klinostat. This can best be accounted for, as Noll[7] suggests, by the supposition that the equally distributed stimulus tends to produce a simultaneous increase and decrease of growth-rate on opposite sides of the rotating plant.[8] We, therefore, get in an indirect way evidence in favour of what has not been directly proved—namely, that in geotropic curvature the diminution of growth

[1] Jost (02).
[2] Darwin and Pertz (04). By an oversight we omitted to give a reference to Němec's (02, p. 347) interesting reply to Jost's criticism
[3] Jost (02), p. 175. See also Czapek (98), p. 206; and Noll (00), p. 462.
[4] Czapek (98), p. 183.
[5] Elfving (84) proved that the pulvini of grass haulms increase in length when kept in slow rotation on a klinostat.
[6] My experiments on the germination of Cucurbita demonstrate the same point (Darwin and Acton, 94) Czapek (02, p. 469) shows that the homogentisin reaction occurs on the klinostat.
[7] Noll (92, p. 35).
[8] We have shown (Darwin and Pertz, 04) that in *Setaria* the statoliths undergo changes of position on the klinostat, indicating a succession of stimuli. See Heine (85), who briefly describes similar changes.

on the concave side is not the result of compression produced by increased growth on the convex side, but rather an independent reaction. It is necessary, therefore, to inquire what theoretical conclusions may be fairly made as to the stimulation correlated with such a mechanism of curvature. Noll[1] uses the term "Reizfeld," or "stimulation-area," to express the regions in which graviperception occurs. The distribution of these areas is expressed in diagrams which serve as shorthand methods of recording the geotropic reactions of various organs. All such ways of clarifying and expressing our ideas of the laws of perception are useful. I must confess that I do not find Noll's terminology easy to use, and I prefer to express the same ideas in terms of the distribution of the pressure of statoliths on the different parts of the ectoplasm of the gravisensitive cells.

Imagine an apogeotropic shoot placed in the horizontal position as shown in longitudinal radial section in Fig. 2, where C and C′ are the cortical tissues and the seat of motile power; E and E′ the endodermis, the supposed region of graviperception; M, the central tissues, which do not concern us.

The fact that the statoliths now rest on the horizontal (tangential) walls differentiates the horizontal from the vertical position of stable equilibrium. But what circumstance is there that can be conceived to originate curvature in one direction more than another? It can only be that in the endodermis E on the physically upper side the statoliths rest on the inner tangential wall, whereas in E′ they

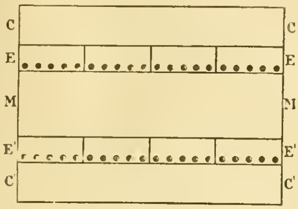

FIG. 2.

rest on the outer wall. This view agrees with Noll's hypothesis of the arrangement of stimulation-areas. There is no difficulty in believing that the inner and outer tangential walls have different individualities: Vöchting's work[2] on transplantation seems to indicate that this is the case. And if this analogy with formative polarity is not allowable, we must still insist that the presumption is in favour of E and E′ in Fig. 2 being in different conditions, since we have certainly no right to assume that the outer and inner walls are identical in what we have called their individuality.

It is not here necessary to go into the question whether the radial walls of the endodermis are or are not sensitive, since the problem of geotropism in its broad outlines is not concerned with it.[3]

The Position of Maximum Stimulation.

This problem involves the question whether an orthotropic organ in the vertical position is or is not freed from stimulus. We will first take the question as to the existence of a stimulus in the normal (*i.e.*, not the inverted) position. One of Pfeffer's[4] arguments for the existence of a stimulus is as follows. A root having been allowed to curve from the horizontal to the vertical position is placed on a klinostat, and after a time the curve disappears. It is therefore assumed that there existed a geotropic stimulus keeping the root curved until the stimulus in question was rendered inoperative by the klinostat, when the rectipetality of the root could have free play. But it is not a necessary conclusion that while the root is strictly vertical any stimulus is acting. If from some internal cause the root leaves the vertical, the ordinary geotropic curvature depending on the

[1] Noll (92, p. 19). [2] Vöchting (92, p. 151).
[3] See the discussion in Haberlandt (03, p. 467).
[4] Pfeffer (93, p. 19). I am only concerned with this special point, not with Pfeffer's general argument.

stimulation of the tangential walls will come into action and bring the root back to the vertical. To translate into the language of the statolith theory, it is not necessary to assume that the lower walls of the graviperceptive cells are sensitive to the pressure of the statoliths—the sensitiveness of the tangential walls will suffice. The experiment above mentioned does not therefore seem to prove that an orthotropic organ in stable equilibrium is stimulated. But it is quite conceivable that a stimulus might be originated by the *loss* of pressure on the lower wall, for this would be a well-marked change in the internal condition of the cell, and therefore might become associated with a reflex. Thus, when an organ is placed horizontal the stimulus from the pressure of statoliths on the lateral walls (now horizontal) may be combined with, or in some way influenced by, the loss of pressure on the terminal wall of the cell which was formerly horizontal. But if the absence of pressure on a cell-wall acts in this way are we not bound to consider the pressure (when present) as a stimulus? I think we are, and therefore, though I do not think that the particular experiment referred to supplies the necessary evidence, I hold the lower wall of an orthotropic cell to be sensitive to the stimulus of statoliths, though such stimulus cannot be of a *directive* nature.

Since an organ when accurately inverted[1] and prevented from circumnutating receives no impulse to curve, it is assumed that the normally upper cell-wall (which is now below) is not stimulated. According to the statolith theory it is inconceivable that the organ should curve, since uniform pressure on the horizontal terminal wall cannot determine the *direction* in which such curve shall begin.

But though no directive stimulus seems to be a possible result of uniform pressure on the end-walls, it does not follow that such pressure has no effect. It seems to me that such a striking change as pressure on a wall which in normal circumstances does not receive pressure may very well modify the result of the normal stimulation of the lateral walls of the cell.

Czapek[2] has shown that with both stems and roots the gravistimulus is greater when the organ is removed from the normal vertical position by 135° than when it deviates from the normal by 45°. In the case of an apogeotropic shoot the position of the starch in the endoderm is given in Fig. 3. The pressure of the starch on the lateral walls is the same in the two cases. In i., however, the starch rests partly on the basal wall (B), while in ii. it rests, to the same degree, on the apical wall (A). On the usual assumption that the basal and apical walls are insensitive, there is nothing to differentiate i. from ii. I cannot help suspecting that the pressure on the apical wall does in some way affect the sensitiveness of the tangential walls. If the pressure on the wall (A) was in itself the decisive element we should expect the stimulus to increase as the angle increased —from 135° to nearly 180°—which is not the case. From my point of view we can dimly understand why 135° should be the position of maximum stimulation. It would be the result of a compromise, being a position in which the combined pressure on both lateral and apical walls was as high as possible[3]—a mean, in fact, between full pressure on the lateral walls (as in the horizontal position) and full pressure on the apical walls (as in the vertical position).

If some such theory is not adopted we must imagine with Haberlandt that the difference between positions i. and ii. depends on the weight of the statoliths in i. being on the *basal half* of the lateral wall, and on the apical half in ii. It seems to me that the difference of sensitiveness in the two regions would have to be very great, considering that in the horizontal position, in which the gravistimulus is less than in position ii., the full pressure of a considerable fraction of the total starch acts on the supposed extra-sensitive region of the cell-wall.

But when all has been said there remains a difficulty with which I do not know how to deal. It is clear that, according to either theory, the critical position should be the hori-

[1] In the whole of this discussion the organs are supposed to be supported by the morphological base.
[2] Czapek (95, 1). As doubt has been expressed as to the actual facts, it is worth while mentioning that Miss Pertz (99) has confirmed his results for the haulms of grasses.
[3] The fact that at angles above 135° the stimulus remains greater than when the organ is horizontal seems to point to the conclusion that the share of the end wall in graviperception is relatively great.

zontal, and that as the organ is moved further and further from the normal (in successive experiments) the geotropic reaction ought to increase decidedly as the horizontal is passed; and this is not the case.

Diageotropism.

The diagram, Fig. 2, will serve to represent a diageotropic organ in stable equilibrium. In spite of the fact that it is at rest in the horizontal position, we must assume that the tangential (horizontal) walls of the endodermis are sensitive to the pressure of the statoplasts. For when the organ is placed obliquely it has the power of returning, by curvature, to the horizontal; and this requires that the plant shall distinguish up from down. If its apex is above the horizon it must curve downwards, *i.e.*, towards that side on which the statoplasts rest on the *external* walls of the endoderm cells, and *vice versa* if the apex is below the horizon. But what signal tells the plant that it is not horizontal? This can only be effected by the statoplasts pressing on the basal or apical walls, as in Fig. 3.

The difficulty is increased by the fact that when a diageotropic organ is fixed vertically, the apex being up or down,[1] no curvature follows. This, according to the usual idea, would mean that the terminal walls are not sensitive. But the walls must be sensitive in some way, or the plant would not react to the gravistimulus, as it undoubtedly does. The only conclusion I can come to is that the position of the statoliths shown in Fig. 3, in which they rest partly on the terminal wall and partly on the lateral (tangential) wall,

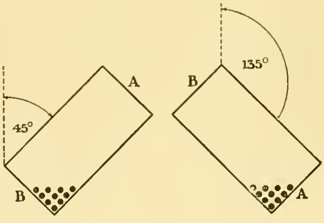

FIG. 3.

must be capable of giving the combined stimulus,[2] as above suggested.

Personally I do not attach great importance to the details of how the statoliths act on the different walls of the cells, although as part of the history of the inquiry I feel bound to discuss it. The broad fact that the statoliths rest on different parts of the cell-walls when the geotropic organ is placed at different angles with the vertical seems to me sufficient. The precise manner in which various reactions are associated with the position of the statoliths may be confessed to be for the present beyond our knowledge or powers of imagination, and such confession need not weaken the position of our theory.

Finally, I desire to say a word on a subject having but a remote connection with my theme. There is at the present time a tendency to pay an increasing attention to what is known as rectipetality or autotropism—viz., the inherent capacity of rectilinear growth. In my Cardiff Address[3] to Section D I showed that rectipetality is really part of the phenomena of circumnutation. We must believe that rectipetality does not merely come into play in those comparatively crude experimental instances in which a geotropic curvature is flattened out by means of growth on the klinostat. We must believe that it also corrects curvatures which arise from the slight irregularity of normal everyday growth. This will imply that normal growth is built of a series of internal corrections; in other words, of circumnutation. The point I wish now to emphasise is that the stimuli, be they of geotropic or any other nature, should be conceived as acting not on a stationary but on a moving plant—acting, in fact, on the spontaneous correcting power, whether we call it rectipetality, autotropism, or circumnutation. It is impossible to say how this consideration might modify our speculations as to the manner of action of the gravistimulus. It is quite conceivable that it might not alter our theoretic views at all, but without more knowledge we cannot be certain. My only point at present is that if we are led into contradictions or confusion by attempts to analyse what goes on in the gravisensitive region according to the statolith theory, such a result must not be held to be fatal to the theory until we know more of the problem.

In conclusion—and to clear our minds of the doubtful speculations in which I have entangled myself—I should like to reiterate my belief in the general, though not the universal, applicability of the statolith theory. I find it impossible to doubt that, in the case of the higher plants, sensitiveness to the pressure of heavy bodies will be found to be by far the most important, if not the exclusive, means by which gravity is perceived. We have seen that the stimulus must depend on weight; and since neither the theory of radial pressure nor Noll's supposition of stimulation by small unknown bodies lends itself to experimental inquiry we are driven, as practical people, to test the views of Haberlandt and Němec.

I base my belief partly on what I have already said, namely, that geotropism, being an adaptive reflex action, must during its development have been correlated, by that mysterious bond which unites stimulus to reaction, with some change, by which in the natural course of events it is uniformly preceded. Now the most obvious change which precedes geotropism is the disturbance of the falling starch-grains. This fact, together with what we know of the distribution of statoplasts, would almost force conviction on me. But this is not the whole of the evidence. We know from Nemec's researches that the protoplasm, in the cells assumed to be sense-organs, is sensitive to the pressure of the statoplasts; and we know from zoological evidence that heavy bodies resting on a sensitive surface can function as a sense-organ for gravitation. Finally, the experimental evidence, though not absolutely convincing, has not revealed any absolute bar to our belief in the statolith theory, and has brought to light a number of facts harmonising with it in a remarkable manner. It seems to me that the theory of Nemec and Haberlandt may fairly hold the field until a better theory of graviperception and a better theory of the function of falling starch-grains are established.

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[1] Czapek (98, p. 243). Noll (92, p. 37) had foreseen on theoretical grounds that this would prove to be the case. See also Noll (90, p. 473).

[2] In Noll's diagram of the stimulation-areas in a diageotropic organ the obliquely placed areas seem to suggest a similarity to what is here given [see Noll (92, p. 29)]. But his stimulation areas in which only a single statolith occurs are not strictly comparable to cells containing numerous statoplasts.

[3] F. Darwin (91).

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THE SIXTH INTERNATIONAL CONGRESS OF ZOOLOGY.

THE smoothness with which the complicated arrangements for the reception and housing of so many guests were carried out, and the kindness and hospitality of the welcome extended to them, formed a good augury for the success of the sixth International Congress of Zoology, which opened at Berne on Monday, August 15. On the previous day the members, gathered from many parts of the world, were received by the reception committee at the railway station, and invited afterwards by the Mayor of the city to a "symposium" in the "Kornhauskeller." The gaiety of the assembly, which did not break up until a late hour, formed an agreeable prelude to the work of the congress, which was throughout interspersed with pleasant entertainments.

At the general meeting the next morning Prof. Studer, the president, chose as the subject of his address the Swiss fauna, to the study of which he has devoted so much of his life. Prof. Perrier, of Paris, as president of the permanent committee, thereupon expressed his feelings of gratitude to the Swiss Government and to the authorities of the canton of Berne for the hospitality which had been extended to the members of the congress. The following gentlemen, Profs. Studer, Minot, Grassi, and Perrier, were afterwards elected presidents for the general meetings, and Profs. Emery, Fujii, Spengel, Osborn, v. Graff, Pelseneer, Lönnberg, Blanchard, Chun, v. Wijhe, Lang, and Drs. Horvath, Stejneger, Stiles, and Miller as vice-presidents. The meeting also agreed to divide into seven sections, viz.:—General Zoology, president, Prof. Salensky; vice-president, Mr. Schlumberger; secretary, Dr. Gurwitsch. Vertebrata (systematic), president, Dr. Jentink; vice-president, Dr. Scharff; secretary, Dr. André. Vertebrata (anatomy, &c.), president, Prof. Monticelli; vice-president, Dr. Bashford Dean; secretary, Dr. Penard. Invertebrata (excluding Arthropoda), president, Prof. Ehlers; vice-president, Prof. Koehler; secretary, Dr. Fuhrmann. Arthropoda, president, Prof. Heymons; vice-president, Dr. Janet; secretary, Dr. Steck. Applied Zoology, president, Prof. Hoek; vice-president, Prof. Plate; secretary, Dr. Duerst. Zoogeography, president, Prof. Hérouard; vice-president, Prof. Blasius; secretary, Dr. Roux.

Two propositions had been received by the president, Prof. Studer, one from the Prince of Monaco, to hold the next congress at Monaco, and another from the zoologists of the United States of America. After due consideration of these proposals, it was decided by the permanent committee and by the delegates of the scientific societies to recommend that the latter invitation be accepted, which was unanimously adopted at the general meeting. It was therefore agreed that the next congress, in 1907, should be held at Boston, and that Prof. Agassiz be asked to preside. Prof. Minot expressed the hope that it might be possible to place at the disposal of the European zoologists a large steamer, which would call for them at Hamburg, Cherbourg, and Southampton.

Subsequently, Prof. Blanchard gave an interesting address on the production of disease in man by animal parasites, and also pointed out in how many ways zoological discoveries had aided not only the elucidation and diagnosis of disease, but also its cure; after which Prof. Lang made some remarks on the life of the Swiss naturalist, Alexander Morizi, born in 1806 at Chur, who, some years before the appearance of Darwin's "Origin of Species," had published a paper in which he promulgated the theory of evolution and supported the view that man had evolved from the higher animals.

At one of the later general meetings, Profs. Salensky, Osborn, Chun, Hoek, and Sarasin delivered addresses. Prof. Salensky referred to the results of the most recent investigations of the life-history and anatomy of the mammoth, and exhibited photographs of a specimen *in situ* (already noticed in NATURE), as well as preparations of the skin, muscles, hairs, &c. It seems now to be a well established fact that the mammoth was a northern species feeding especially on conifers, but also on cyperaceous, gramineaceous, and leguminous plants. The recently discovered stages in the evolution of the horse and contemporary mammals in North America formed the subject of Prof. Osborn's lecture, while Prof. Chun dealt with the vertical distribution of the marine plankton.

Altogether more than four hundred zoologists, many of whom brought one or more members of their family, took part in the congress. The general meetings were held in the large hall of the Swiss House of Parliament, and the sections met in the lecture rooms of the splendid university buildings, of which the country is justly proud.

I.—GENERAL ZOOLOGY.

It has been assumed that the South American Stegomyia was the means of transferring a blood parasite to man, which gave rise to yellow fever; Prof. Goeldi, of Para, however, gave reasons for his belief that this disease is not due to any blood parasite, but to an organic toxin which he discovered in the saliva of Stegomyia.

The zoological aspect of De Vries's mutation theory was discussed by Prof. Plate, who recognised that the theory signified an important advance of knowledge in so far as it showed that sudden changes could arise in the organism which were highly transmissible, but he urged that a sharp morphological boundary could not be drawn between variations and mutations. The former must be considered as changes with a slight capacity of inheritance, the latter as such with a high capacity.

As the result of anatomical investigations in butterflies, Mr. Petersen, of Reval, attempted to show that all species can be distinguished morphologically by their reproductive organs, and that it is through physiological isolation that varieties form the starting point for new species.

Prof. Maas reviewed the experiments he had carried out in depriving young sponges of carbonate of lime before their metamorphosis.

Prof. Vejdovski demonstrated the presence of a nucleus in *Bacterium Gammari*, already described (*cf. Centralblatt f. Bakteriologie*, 1901 and 1904), while Prof. Looss, of Cairo, indicated how the larvæ of Ancylostomum and Strongyloides migrate through the hair-follicles of the human hand into lymph- or blood-vessels, and from there reach the intestine by way of the heart, lungs, and air passages.

II.—VERTEBRATA (*Systematic*).

Several papers of particular interest were discussed in this section. Among these may be mentioned that of Prof. Scott, of Princeton, on the Miocene mammals of Patagonia. He referred to the fact that the fossil rodents all belong to the Histricomorpha, of which South America is still the headquarters. The Edentata are represented by the three orders Gravigrada, Dasypoda, and Glyptodontia. Several orders of ungulates, he remarked, displayed striking similarities to northern orders, but these similarities must be looked upon as convergent developments, and not due to a common descent.

Mr. Bieler, of Lausanne, described the skull of an extremely small bear obtained in the Alps some years ago, which he identified as belonging to *Ursus formicarius*.

An artificially produced hybrid between *Triton cristatus* and *T. marmoratus* was exhibited by Dr. Wolterstorff, who remarked on its identity with *Triton Blasii*.

Mr. Borodine, of St. Petersburg, described the herrings of the Caspian, in which sea he was able to distinguish no less than five species, three of which were essentially marine forms.

Recent studies and discoveries in the evolution of the horse, with lantern demonstrations, formed the subject of an interesting lecture by Prof. Osborn, who mentioned that more than a hundred more or less complete skeletons of horses and horse-like animals had been found fossil in North America. He thought he had established the fact that horses were polyphyletic, there being four or five contemporary series in the Miocene, but that the direct origin of the genus Equus in North America was not established with certainty.

Prof. von Méhely's paper dealt with the skull and dentition of the species of Spalax, a small East European rodent. As the result of his careful investigations he was able not only to demonstrate that the twelve species described hitherto could be reduced to three, but that the origin of the latter was clearly traceable from an extinct form by gradual mutations, due chiefly to selection.

Prof. Tornier dwelt on the subject of the origin and significance of the coloration of the skin in reptiles, and attempted to demonstrate that those parts which were folded during the animals' movements were less well nourished than the remaining parts, and were therefore lighter in colour.

III.—VERTEBRATA (*Anatomy and Embryology*).

Dr. Kerbert referred to the fact that the giant salamanders of Japan in the aquarium at Amsterdam had produced young, and described the eggs of the species; while Dr. Bashford Dean, of New York, pointed out the peculiarities in the development of *Chimaera Collici*.

The specimens of Ceratodus brought back from Australia by the Semon Expedition enabled Prof. Burckhardt, of Basle, to undertake some anatomical investigation of its central nervous system, of which the author exhibited illustrations and models, and he also showed some reconstructions of fossil vertebrates not hitherto figured.

Prof. van Wijhe, of Groningen, gave a demonstration on the development of the skull in elasmobranchs, while Prof. Lönnberg, of Stockholm, exhibited a fœtal *Elephas cyclotis*, and made some remarks on the homologies of the avian bill.

Dr. Helbing, of Basle, communicated the results of his investigations on the anatomy of Læmargus, and Mr. Bles spoke on the hatching of Anuran tadpoles and the function of Kupfer's "Stirnknospe." He also exhibited Prof. Kerr's slides of the early development of the motor nerve trunks in *Lepidosiren paradoxa*.

IV.—INVERTEBRATA (*exclusive of Arthropoda*).

Prof. Meyer, of Kasan, described the primitive ambulacral system in Echinoderms, and the diaphragm-sacs which serve to swell the head tentacles in terrebelloid annelids, and discussed the theoretical bearings resulting from a comparison of these somewhat similar structures.

Prof. Salensky gave an account of the prototroch, and also referred to the formation of cœlomesoblast of the larva of Echiurus, while the morphology of the cardial organs of Appendicularia formed the subject of another of his papers.

A description of the mode of nutrition of the embryos of Purpura was then given by Prof. Pelseneer. It appears that the majority of the ova undergo an irregular segmentation and form a vitelline mass, on which a few embryos fix themselves and absorb it completely.

Profs. Caullery and Mesnil exhibited preparations of two cœlomic annelid parasites. The first of these, *Pelmatosphaera polycirri*, forming numerous spheres, is allied to the Orthonectida, and lives in the general body-cavity of the host. The next, *Sphaeractinomyxon Stolei*, is the first marine representative of the Actinomyxidæ, and inhabits marine Oligochæts.

Prof. Fuhrmann, of Neuchâtel, described the three known species of Cestodes in which the sexes are in distinct individuals, and which are characterised by very marked dimorphism.

It was urged by Prof. Monticelli, of Naples, that the Temnocephala, for which he proposes the name of Dactyloda, should be looked upon as constituting a group distinct from the Platelminthes.

The most exciting exhibition in this section, and, indeed, one of the most fascinating features of the congress, was a kinematograph demonstration of the development of one of the Botryllidæ. These were kept in a flat-sided glass jar to which a constant stream of fresh sea-water was supplied. Taking a series of photographs at certain regular intervals by means of an ingeniously constructed registering camera, Prof. Pizon, of Nantes, succeeded in producing before the audience a continuous and rapid picture of the gradual evolution of the colonies of the Tunicate. Prof. Marey had shown us some years ago how the quick movements of animals such as the horse and the dog could be reduced on the screen to slow motions, while Prof. Pizon now demonstrated how this can be accomplished in a converse manner.

V.—ARTHROPODA.

Most of the papers in this section dealt with ants. Dr. Forel brought forward some new biological observations, in the course of which he mentioned that there were now about 4000 species known, and 900 varieties; while Prof. Emery discussed the origin of ants' nests; Dr. v. Buttel-Reepen the insect colonies in general; Mr. Piéron the problem of recognition among ants; and Prof. Goeldi, of Para, the mushroom gardens constructed by *Atta cephalotes*.

A few other papers dealt with Lepidoptera, such as that of the Countess v. Linden on the influence of the withdrawal of oxygen during the pupal stage on the shape of butterflies, and that of Mr. Pictet on variations produced in butterflies by changing the food of their caterpillars and by humidity.

Two communications deserve a special reference, viz. Prof. Blanc's discovery of a Caprellid in the Lake of Geneva, and Prof. Heymons's paper on the development of the Solifuga. Prof. Blanc exhibited a female specimen of an undescribed Podalirius, a marine genus of crustacean, and mentioned that other invertebrates allied to marine forms were known to inhabit the lake. The development of the Solifuga agrees, according to Prof. Heymons, in all important respects with that of the Arachnida, but it offers no clue to any closer relationship with insects, as some authors seem to think.

V.—APPLIED ZOOLOGY.

Dr. Jentink's discourse on the ideal natural history museum was delivered in this section. The director of the

Leyden Museum advocates the complete separation of the study and exhibition series, and insists on the great importance of the absolute protection of the specimens from fire, dust, and light.

Prof. Plate described a new microscope suitable for exhibition in museums; Prof. Forel a new method of collecting specimens inhabiting the deep water in lakes; while Prof. Fujii, of Tokyo, referred to some micro-technical apparatus of his own invention.

Finally, a demonstration was given on the installations of the "concilium bibliographicum," by Dr. Field.

VII.—ZOOGEOGRAPHY.

Mr. Schmidt, of St. Petersburg, explained the distribution of the fishes in the northern Pacific, and mentioned that the northern fauna of Japan should be considered as belonging to the Arctic region, and that the fishes of southern Japan and the west coast of North America are very distinct from those of the northern parts.

Prof. Simroth gave his views on the origin of the Alps, based chiefly on the distribution of the Mollusca. Dr. Pellegrin, of Paris, described the fish-fauna found in Lake Tchad and the Chari River, which he declares to be very similar to that of the Nile.

Prof. Forel gave his experiences on the occurrence of *Larus ridibundus* on the Lake of Geneva. It appears that thousands of these gulls are present on the shores of the lake during winter, and that they migrate northward in March, to return again in October with their young. A few remain all the year round. The principal lines of migration of birds across Switzerland were then described by Prof. Fatio, of Geneva.

The congress ended with a couple of days of most pleasant social intercourse. The members were afforded an opportunity of seeing the beauties of the Bernese Oberland during an excursion along the Lake of Thun, and an afternoon spent at Interlaken, where a final meeting was held in the "Kursaal." Saturday was devoted to a trip to Geneva, where, after a lunch and a visit to the museums, the venerable Mr. de Saussure entertained the guests at his country seat near the city, and a Venetian *fête* with fireworks brought the congress to a close.

ROTATION OF SATURN'S RINGS.

ON 1903 November 6, 5h. 25m., I observed a large diffused white spot a little north-east of the extremity of the western ansa. It was placed on the bright rim of the interior ring, just bordering Cassini's division, and appeared to extend faintly over the outer ring.

November 7 was cloudy, but on November 8 there was a clear sky and pretty good definition, but no certain differences of tint could be remarked in the individual rings.

On November 9, 5h. 10m., the planet was very faint, and the two ansæ seemed equally bright. At 5h. 50m., however, the western ansa was decidedly the more luminous, and the aspect appeared similar to that on November 6.

November 10, 11, 12, and 13 were cloudy; November 14 was stormy with fine intervals, but definition was very unsteady, and no white spot could be discerned on the rings.

On November 15 there was a clear, frosty sky. At 5h. 50m., under good definition, the ring seemed notably brighter on western than on eastern ansa.

On November 16 definition was very bad, and no details could be satisfactorily made out. November 17 was cloudy.

On November 18, 5h. to 5h. 40m., there was a good deal of fog, and the planet's image appeared very faint. The western ansa seemed decidedly brighter than the other, but the luminosity appeared diffused and not caused by a definite spot.

No satisfactory observations were secured after the latter date. The weather was extremely unsettled, and definition generally very bad, so that though the planet was examined, whenever visible, until December 11, no further inequalities in the luminosity of the rings were noted.

The bright area seen on November 6 and several other evenings appeared recurrent in same position at intervals of 3 days, whence I infer that the rotation period of the ring is about 14h. 24m. This determination is, however, extremely rough, and only useful as affording evidence of the approximate value.

After I had arrived at this result, I consulted various authors to find what previous estimates had been made as to the rotation of the rings.

Laplace theoretically computed that the ring ought to rotate in 10h. 33m. 36s. (Chambers's "Descriptive Astronomy," third edition, p. 143). In Laplace's "System du Monde," however, it is stated that Saturn rotates in 0·428 day and the ring in 0·437 day, the equivalents being =10h. 16m. 17·2s. and 10h. 29m. 16·8s.

Sir W. Herschel, from a spot or luminous point seen on the interior ring in July, 1789, ascertained that the ring revolved round the ball in 10h. 32m. 15·4s. (*Phil. Trans.*, 1790, vol. lxxx. p. 479).

Secchi obtained many measures of Saturn's system in 1854–6, and apparently detected an ellipticity in the rings, for the discordances were considerable, and harmonised at intervals of 3 and 9 days. He concluded that a period corresponding to that which a satellite would have if situated on the outer ring, viz.

14h. 23m. 18s.,

would satisfy them (*Monthly Notices*, vol. xvi. p. 52). The correspondence between Secchi's period and my own roughly ascertained value, being quite independent, is rather singular.

Now that Saturn is very favourably visible, it is to be hoped that observers will frequently examine the rings for differences in tint or tone which may afford material for the rotation period to be re-determined.

W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE title of professor has been conferred on Dr. Karl Schreber, of Greifswald, for physics, and on Dr. Robert Pschorr, of Berlin, for chemistry.

MR. ALEXANDER LAUDER, senior demonstrator in chemistry in the University College of North Wales, Bangor, has been appointed lecturer in agricultural chemistry in the Edinburgh and East of Scotland College of Agriculture.

IN connection with the technical college which will shortly be proceeded with at Stoke-on-Trent, it is proposed to have a school of pottery, which shall not only train pupils, but also act as a central advisory and analytical department for manufacturers. There will also be a mining department. The estimated cost of the building, some 25,000*l.*, has been practically assured, the North Staffordshire Institute of Mining and Mechanical Engineers contributing 4000*l.*, the Staffordshire County Council 4000*l.*, the training authority 6000*l.*, while close on 10,000*l.* has been promised as voluntary contributions.

DR. ANTON LAMPE and Dr. Hans Benndorf, of Vienna, and Dr. F. Streintz, of Graz, have been appointed extraordinary professors of physics. Herr Reinhold Lutz has been appointed professor of mechanical engineering at the Aachen Technical College, Dr. George Schlesinger professor of the theory of mechanical implements in the Berlin Technical College. Dr. Karl Rohn, now professor of geometrical drawing in Dresden, has been appointed professor of mathematics in the University of Leipzig as from April 1, 1905. Dr. Ludwig Prandtl, now professor at Hanover, has been appointed to the chair of technical physics and agricultural mechanics at the University of Göttingen.

THE calendar for the session 1904–5 of the Merchant Venturers' Technical College, Bristol, indicates several improvements which have been made recently at this institution. Among these may be mentioned the new experimental steam engine, with its boiler and measuring appliances, and the experimental light and power station now in use by the students. The courses for engineering students have been re-arranged, and provision has been made for a fourth year's course in civil, mechanical, and electrical engineering. The staff of the engineering departments has been strengthened by the appointment of an additional lecturer.

SIR HENRY CRAIK, K.C.B., in his report for the year 1904 on secondary education in Scotland, says that the examiners are of opinion that the teaching of theory is still the weak point in the instruction in science given in the schools, though there has been some improvement since last session. This weakness is specially conspicuous in the subjects of magnetism, electricity, and hydrostatics. It would appear that most teachers rely too exclusively on the experiments done by the pupils in the laboratory, and do not supplement them sufficiently by full discussion and cross questioning, and by demonstration experiments. It is to be feared that the subjects mentioned are too often attempted by boys who are not sufficiently equipped with a previous knowledge of mathematics and dynamics, who would have been much more profitably employed in going through a course in heat or chemistry. It is satisfactory to find evidence of a tendency to simplify the courses followed in the schools.

THE Higher Education Subcommittee of the Lancashire Education Committee has issued a series of circulars detailing the provision made in the county for instruction in various branches of agriculture. In the first of the pamphlets full particulars are given of a scheme of agricultural education to be carried out at the County Council Farm, Hutton, the Harris Institute, Preston, and in various parts of the county during the session of 1904–5. The course in agriculture at the Harris Institute, Preston, extends over four years, and is intended to prepare youths for the practical work of a farmer's life by instructing them in the principles which underlie farming operations, and demonstrating—in the lecture room and on the farm—modern and scientific methods of agriculture. The instruction is free to approved students, and, in addition, the County Council allows a sum not exceeding ten shillings per week, either for board, lodging, or for travelling expenses, to each student in full attendance, not being a holder of an agricultural scholarship, who fulfils certain conditions laid down. The Higher Education Subcommittee has also made arrangements to consider applications from local committees, agricultural societies, and farmers' associations, for courses of lectures by members of the agricultural staff at the Harris Institute, Preston.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 29.—M. Mascart in the chair.—On the fall of Perseids in 1904: Henry **Perrotin.** The most favourable evenings for observations were August 9 to 14. Owing to the exceptional purity of the atmosphere at the summit of Mont Mounier (2740 metres) a large number of meteors were noted. As regards their points of appearance, disappearance, velocity, and brightness, the results clearly indicate the advantages possessed by stations at high altitudes for methodical observations of meteors.—On the approximate solution of certain congruences: Frédéric **Riesz.**—On the formulæ of tonometry and cryoscopy: E. **Ariès.** In a preceding communication it has been shown that the expression for the potential of each of the two substances in a dilute solution can be deduced from the law of van 't Hoff. In the present paper these results are extended to include the formulæ connecting the alteration of vapour pressure and of freezing point, deduced experimentally by Raoult.—On a case of globular lightning at Autun on July 16: M. **Roche.**—On the theory of macles: G. **Friedel.**—The passage from the root to the stem in *Primula Auricula*: H. **Ricome.**—Researches on the assimilation of some ternary substances by the higher plants: P. **Mazé** and A. **Perrier.** From the experiments described, it is shown that green plants, like fungi and micro-organisms, are capable of assimilating sugars, the only distinction between the two cases being that the former can create these substances at the expense of atmospheric carbon dioxide, whilst in the latter, the nitrous and nitric ferments are the only ones known to be able to take carbon from carbonic acid.—On the preservation of flour by cold: M. **Balland.**

NEW SOUTH WALES.

Linnean Society, July 27.—Dr. T. Storie Dixson, president, in the chair.—Notes on Australian Coccidæ ex Coll. W. W. Froggatt, with descriptions of new species, No. i.: E. Ernest **Green.** A species of Chionaspis found upon the undersurface of the leaves of *Eucalyptus tereticornis*, Sm., and the nut-grass Coccid, a species of Antonina, are described as new. The latter may be classed with the few beneficial species of Coccids, as it is credited with destroying the host-plant (*Cyperus rotundus*, Linn.), a most objectionable weed, over a large area of the Hunter River flats, N.S.W.—Three new generic names for Mollusca: Captain F. W. **Hutton,** F.R.S. The author finds, through the publication of the "Index Zoologicus," that the following generic names, published by him for land Mollusca, have been forestalled:—Pyrrha, by Cabanis in Aves, 1849; Carthæa, by Walker in Lepidoptera, 1858; and Rhenea, by Saalmüller in Lepidoptera, 1884. He therefore proposes the following names to replace them:—Thermia for Pyrrha, Serpho for Carthæa, and Delos for Rhenea.—On a new species of Heteronympha, and a new variety of *Tisiphone abeona*, Don.: G. A. **Waterhouse.**—On four new species of Eucalyptus: J. H. **Maiden.**

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1904, contains the following memoirs communicated to the Society:—

May 14.—Ph. **Furtwängler**: On the construction of the *Klassenkörper* for any algebraic *Zahlkörper*. Lothar **Heffter**: On the definition of the definite integral in two dimensions, independently of previous integration. G. **Prasad**: On the notion of lines of curvature.

June 11.—J. **Stark**: Experiments on the genesis of the band- and the line-spectrum.

June 25.—David **Hilbert**: Principles of a general theory of linear integral equations.

CONTENTS.

THURSDAY, SEPTEMBER 15, 1904.

NEW AND OLD VIEWS ON GLACIATION.

Die Gletscher. By Dr. Hans Hess, königl. gymnasial-Professor in Ansbach. Pp. xii+426. (Brunswick: F. Vieweg und Sohn, 1904.) Price 15 marks.

THE author of this closely written treatise reminds us that it is nineteen years since Heim issued his classical "Handbuch der Gletscherkunde," and that the numerous additions to our knowledge since 1885 may well be brought together in a convenient form. Dr. Hess has an intimate personal knowledge of European glaciers, on which he has made patient and numerical observations; and in the difficult matter of the theory of glacier-motion he has had the cooperation of Prof. Finsterwalder, of Munich. The work of Finsterwalder, indeed, is in many ways an inspiration throughout the book, but the references to Chamberlin, Brückner, Drygalski, Penck, Reid, and many others show what an immense amount of material has been added to our knowledge in very recent years.

In summarising the conclusions of these authors, the work of Dr. Hess becomes somewhat encyclopædic, and it will be felt, according to the idiosyncrasies of the reader, that certain subjects are unduly dwelt on, while others are summarily compressed. Those who live in countries that were at one time buried under confluent sheets of ice will wish to see an extended history of Polar and Alaskan glaciers, and a further discussion of the widely spread moraine-material which appeared on their melting and retreat. The mention (p. 388) of Kames and Eskers as "durch die Schmelzwasser geformte Hügel in den Schotterbänken" will hardly satisfy dwellers in Britain or Scandinavia, not to say the Prussian plain; nor does it represent the views recently accepted by Prof. Jas. Geikie, from whose work it is professedly a translation. We ought, however, to be willing to refer to memoirs on special districts when pursuing inquiries such as these, and we may well be grateful to Dr. Hess for the new details brought to our notice from the regions in which he himself has studied.

The book opens with a review of previous observation, in which priority is accorded to John Playfair for realising the meaning of erratic blocks so far back as 1802. The physical characters of ice are then discussed, and full stress is laid on the recognition of ice as a viscous body, yielding to pressures and adapting itself to its surroundings. Glacier-ice (p. 20) suffers some reduction in plasticity owing to the admixture of sand and dust. The discovery by McConnel and Kidd, and by Emden, of the plasticity of the individual ice-crystal led Emden (p. 316) to remark that a glacier consisting of a single crystal at the temperature of its melting point would move precisely as a granular glacier. Regelation, as an explanation of glacier-motion, though still holding its own in physical text-books, has been set by geologists in the second place in recent years. In the regeneration of fractured glaciers, however, as Hess points out, this phenomenon plays a most important part.

We could wish that the tenth section, on the theory of glacier-movement, had followed closely on the first, and had thus offered an explanation of much that is obscure in the earlier chapters of the book. The development of Finsterwalder's "Strömlinien" is greatly needed during the discussion of moraines, and readers of so special a treatise are naturally familiar enough with general physical geography and the form of glaciers to understand the exposition of Finsterwalder's views at an early stage. This exposition, from p. 325 onward, shows how every point in the surface of the firn-basin is connected by a "Strömlinie" with a corresponding point on the surface of the glacier lower down. The ice-particle enters the firn at one end of the line, by deposition from the atmosphere, and disappears from the glacier, by melting or evaporation, at the other end of the line. In between, it has had a course within the ice-mass, longer or shorter, according to the form of the rock-floor and of the bounding walls. The lower boundary of the firn marks the line of division between the area where the flow-lines enter the glacier and that in which they emerge upon its surface. While a "Strömlinie" never lies entirely on the glacier-surface, a "Bewegungslinie" is (pp. 138 and 327) the course of a stone dropped upon and remaining on the surface. Shortly, "Strömlinien" emerge at all points along "Bewegungslinien," but do not coincide with them.

Dr. Hess regards the stratified structure of glacier-ice as essentially arising, by natural conditions and irregularities of deposition, in the area of the firn; the appearance becomes intensified by streaming out and extension lower down (p. 173), but has nothing to do with internal pressures. Experimental evidence of this conclusion is provided. An interesting case of unconformity in the bedding of ice-layers is quoted and illustrated from Finsterwalder on p. 177.

The title of the seventh section, "Eis und Fels," reminds us that massive ice is as much one of the rocks of the earth's crust as desert-sand or a reef of coral. Marine limestones are, for instance, formed of material withdrawn from invisible solution in the sea; on one side they may receive almost molecular additions, on the other side they may disappear again by solution. An ice-mass is similarly added to or removed at different points, but it is none the less a rock. Its plastic behaviour, however, among other rocks has led us to think of it as a thing apart, just as we sometimes forget that mercury has a crystallographic form. The chapter in question will attract attention on account of its treatment of moraines, and the belief of the author in the rapidity of the erosion that takes place upon the glacier-floor. From personal observations, which are now being carried further, he estimates this erosion, in specially active cases, as indicating a reduction of the floor-level by 3 cm. per annum. Allowing for the additional influence of water-erosion, which he considers to be far less than that of the moraine-laden ice, he uses the figure of 3 cm., somewhat adventurously, in calculating (p. 376) the age of some of the larger valleys of the Alps.

A fine picture (p. 35) is given to show how the fissile structure of rocks affects their mode of weathering by the ice. The author holds that large blocks are re-

moved from the walls and floor of glaciers wherever the planes of division lie at favourable angles. In this way, medial moraines have a very real existence below the surface of the glacier as well as upon it, since a rocky island yields ice-scratched material over its surfaces of contact with the ice that sweeps round it on either side. "Such medial moraines (p. 194) possess only ground-moraine material"; the word "only," however, seems negatived by the following sentence:—"their constituent débris is not limited to the surface, but reaches right down to the base. In consequence, the débris seen at the surface is not constant in quantity as in the pure medial moraines, but increases in proportion as the end of the glacier is neared, in accordance with the progress of ablation."

Internal moraines may similarly arise from projections in the firn-area; the fragments are carried forward as a wall within the ice. A little diagram on p. 203 makes Finsterwalder's scheme of moraine-structure clear, though it perhaps exaggerates the filmy character of the ordinary ground-moraine.

It has seemed to many geologists that the increasing stress laid on the plasticity of ice, and the ease with which it adapts itself to obstacles, make it all the more necessary to look to frost and storm, and to the erosive action of sub-glacial streams, as the agents by which glaciated hollows are cut out. The passages (p. 361 *et seq.*) on cirques—no such Gallic word is really admitted to this treatise—and the forms of Alpine valleys will show how much room there is for differences of opinion on this point. We fancy that the views put forward by Dr. Hess as to the simple "peneplain" character of the pre-Glacial Alpine slopes will receive considerable criticism from those who have described the successive movements along the mountain-axis in Miocene and Pliocene times. The grouping of the pre-Glacial river deposits of France and Switzerland, as they are traced back into the hills, should give us some idea of the depth of the valleys before the ice spread down into them. The work of rivers at the present day in rapidly destroying the Glacial troughs, and in carving out ravines on ice-worn walls, leads many of us to regard glaciers mainly as moulders and preservers of the basins which they temporarily fill. Dr. Hess, however, extends his support of the excavation-theory to the Scandinavian fjords (p. 388), and it is well to realise that these views, once widely prevalent, have not lost their hold upon men who can measure and observe.

Modern English writers may find their contentions somewhat slightly dealt with, and their names occasionally mis-spelt. Through a certain Teutonicism, moreover, the glacial terms familiar to three-quarters of the globe are omitted from the text and from the index. Scarcely any German work mentions *roches moutonnées*, made classical by De Saussure; but it is hard to see *nieves penitentes* admitted as a newcomer.

In conclusion, Dr. Hess has produced a book that must find a place in every scientific library, both as the work of an original observer and as a record of the active progress of geological research.

GRENVILLE A. J. COLE.

MATHEMATICS FOR SCHOOLS.

Practical Geometry for Beginners. By V. Le Neve Foster and F. W. Dobbs. Pp. ix+96. (London: Macmillan and Co., Ltd., 1904.) Price 2*s.* 6*d.*

Elementary Algebra. Part i. By W. M. Baker, M.A., and A. A. Bourne, M.A. Pp. viii+275+lii. (London: George Bell and Sons, 1904.) Price 3*s.*

A New Trigonometry for Schools. Part i. By W. G. Borchardt, M.A., B.Sc., and the Rev. A. D. Perrott, M.A. Pp. vii+237+xxxv. (London: George Bell and Sons, 1904.) Price 2*s.* 6*d.*

The Elements of Plane Trigonometry. By R. Lachlan, Sc.D., and W. C. Fletcher, M.A. Pp. v+164. (London: Edward Arnold.) Price 2*s.*

Preliminary Practical Mathematics. By S. G. Starling, B.Sc., A.R.C.Sc., and F. C. Clarke, B.Sc., A.R.C.Sc. Pp. viii+168. (London: Edward Arnold.) Price 1*s.* 6*d.*

Constructive Geometry. By John G. Kerr, LL.D. Pp. 122. (London: Blackie and Son, Ltd., 1904.) Price 1*s.* 6*d.*

New School Arithmetic. Part i. By Charles Pendlebury, M.A., F.R.A.S., assisted by F. E. Robinson, M.A. Pp. xv+206+xxi. (London: George Bell and Sons, 1904.) Price 2*s.* 6*d.*

THE Practical Geometry by Messrs. Le Neve Foster and Dobbs consists of a collection of more than seven hundred examples, grouped in sets, each set illustrating some fundamental geometrical principle, the whole covering the subject-matter of Euclid, Book i. There is little or no descriptive matter, but the examples themselves are carefully selected and arranged, so as to lead the pupil by easy steps from experimental quantitative work, in which geometrical truths are discovered, to generalisations based on the knowledge thus obtained. In part i. the examples are entirely practical. In part ii. the work is partly deductive, and this section is intended to supplement the study of pure geometry, and especially to be used in conjunction with Mr. Allcock's "Theoretical Geometry for Beginners." These two parts are followed by a large number of miscellaneous examples and by twenty-six illustrations of geometrical patterns, in which the student finds scope for the application of the knowledge he has obtained. The book will be found very useful in supplementing any elementary text-book which is confined to the abstract reasoning of pure geometry.

A feature of the Algebra by Messrs. Baker and Bourne is the profuse supply of easy and well graduated examples provided at short intervals, enabling even the very backward student who works through them to acquire by almost insensible stages facility in the manipulation of algebraical symbols, and a sound knowledge of algebraical processes. Revision papers are given from time to time, by which he can test his progress. Considerable use is made of squared paper in the graphing of algebraical functions, the solution of equations, and in other ways, thus greatly adding to the interest of the work, and giving a better insight into the nature of the subject. This book is the first instalment of a larger work, to be completed in a second volume. It carries the subject up to the

solution and theory of quadratic equations. The style is attractive, and well suited to beginners. The answers themselves occupy more than fifty pages, and the volume can, if desired, be obtained without these at a reduction in cost.

The movement of reform in the teaching of elementary mathematics has affected trigonometry, and an outcome is seen in the new text-book by Messrs. Borchardt and Perrott, in which the authors have aimed at presenting the subject in a manner suited to the new conditions. Four-figure mathematical tables are provided for general use. Graphs are introduced from time to time. The first endeavour of the authors is to give the student a good working knowledge of the elements of trigonometry, with facility in practical computation. The opening chapters are thus confined to acute angles. Easy problems are solved on heights and distances, but more attention might well have been given to the solution of right-angled triangles under all sorts of conditions, as this is fundamental. In establishing the general formula for angles of any magnitude, the authors have not perceived that a satisfactory account can only be given by introducing the conception of a vector, with the projections of rotation vectors and vector polygons. Consequently, the heart of the matter is missed, and the foundation for future development is not completely laid. The usual formulæ for triangles, and for compound, multiple, and sub-multiple angles are established, the work consisting largely of a mass of trigonometrical transformations. It is not evident why practical applications should be confined to problems in surveying. There are other rich sources to draw from. Thus, an investigation of simple harmonic motion could be made to throw a flood of light on the significance of trigonometrical formulæ, awakening a living interest in dead symbols. This is the first half of the complete text-book. The part which is to follow will contain chapters on De Moivre's theorem, the exponential theorem, trigonometrical series, &c. The book is a fair attempt to teach elementary trigonometry in a more rational manner, but falls far short of the ideal text-book on the subject.

The remarks just made apply generally to the volume by Messrs. Lachlan and Fletcher, except that the whole of the subject-matter, including De Moivre's theorem, &c., is compressed into one small volume, and in order to be suitable for beginners would require considerably to be amplified and supplemented by the teacher.

The "Preliminary Practical Mathematics" by Messrs. Starling and Clarke is the result of experience gained with technical students, who find, when entering the laboratory or workshop, that their mathematical knowledge is not suited to the requirements, and who have not time to enter on an extended mathematical course to supply the deficiency. If the subject were properly taught to boys at school, a book like the present would not be required.

The ground covered in Mr. Kerr's "Constructive Geometry" is substantially that of the first three books of Euclid's Elements, but the treatment of the subject is in accordance with modern ideas, and is very suitable indeed for beginners. Starting with a few concrete objects and using simple drawing appliances for quantitative experimental work, the pupil "is helped to build up ideas about lines, points, triangles, circles, &c., in precisely the same way as that followed in dealing with the elements of physics and chemistry." Deductive reasoning is increasingly employed as the pupil advances, and we think the author is justified in hoping that "there will be as net result an extensive fund of available knowledge on which more advanced work can rest securely, and also such habits of inquiry and thought as will give a stimulus to further study."

The "New School Arithmetic" by Messrs. Pendlebury and Robinson is based on the sixteenth edition of the Arithmetic by the former, the first edition of which was published eighteen years ago. During this time commercial conditions have changed, scientific requirements have advanced, and a reform in the teaching of elementary mathematics has been inaugurated. The authors have aimed at producing a text-book which shall be fully abreast of the times. Thus metric weights and measures are given and used along with British, and these, being introduced at an early stage, afford excellent concrete examples in illustration of vulgar and decimal fractions. The new style of multiplication is used exclusively, and thus at the proper time approximate methods become natural and easy. Squared paper and other graphical illustrations are used with good effect, and algebraical symbols are introduced on appropriate occasions. The present volume deals with money, weights and measures, and examples thereon, with vulgar and decimal fractions, and with the decimalisation of money. The examples are very numerous and well graduated. The style is simple and clear, and altogether this excellent text-book deserves a wide circulation.

OUR BOOKSHELF.

Die Vorgeschichte des Menschen. By G. Schwalbe. Pp. 52+1 plate. (Brunswick: Vieweg und Sohn, 1904.)

THE author of this work is already well known by his writings on *Pithecanthropus erectus*, the Neanderthal skull, and that of Egisheim. The basis of the pamphlet now before us is a lecture delivered by the author at the meeting of the Society of German Naturalists and Physicians, held at Cassel in 1903, but two valuable appendices have been added to the original lecture. The line of argument runs in the main on palæontological and anatomical evidence, though the existence of man in pre-Glacial times is regarded as an established fact. The writer claims for the Neanderthal man a specific distinction from the "homo sapiens" of Linnæus, and would term him "homo primigenius." He traces the relations of this early representative of the human race not only with the *Pithecanthropus erectus*, but with the Dryopithecus and some of the more anthropoid forms of living apes, and in the illustrative plate gives diagrams of the forms of the different skulls. The agreement of the human remains from Spy, in Belgium, with those from the Neanderthal is accepted, and those from the Krapina cave, in Croatia, though varying in the brachycephalic direction, are regarded as belonging to the "homo primigenius." Mr. Schwalbe seems even inclined to accept evidence of the existence of man in Tertiary times. Whether his conclusions can in all cases be adopted without hesitation or not, his arguments are worthy of careful consideration, and the

appendices, which include an extensive catalogue of the literature on the subject of primæval man, will be found to contain a large amount of useful information.

J. E.

Metallurgia dell' Oro. By Ing. Emilio Cortese. Pp. xv+262; 35 incisioni. (Milano: Ulrico Hoepli, 1904.) Price 3 lire.

Metalli Preziosi. By Ing. A. Zinone. Pp. xi+315. (Milano: Ulrico Hoepli, 1904.) Price 3 lire.

NOTHING exactly resembling the Hoepli manuals is published in the English language, though in French the "Encyclopédie scientifique des Aide-Memoire" constitutes a close parallel. The Hoepli series now amounts to 800 little volumes dealing with science, literature, and the fine arts. The method of publishing is useful, and contrasts favourably with the inconvenient system adopted in the old-fashioned encyclopædias with large volumes containing heterogeneous congeries of subjects. The latest additions to the series are neatly bound, well printed with good sized type, and can be carried in the pocket. The book on the metallurgy of gold contains brief accounts of the washing and sluicing of auriferous gravels, and of the crushing and amalgamation of gold ores. There are also chapters on the Plattner and Mears processes of chlorination, on cyaniding, and on the refining and parting of gold bullion. The descriptions are fairly clear and accurate, but some of them deal with antiquated processes. The Newbery-Vautin process, the Crauford mill, and Greenwood's electrolytic process are all described, but on the other hand no mention is made of the use of the lead-zinc couple in the precipitation of gold from cyanide solutions, or of Taverner's lead-smelting process. In the other book, the metals dealt with are silver, gold, and platinum. The properties of these metals and their alloys, and the methods of assaying and treating their ores are briefly described, and the remaining eighty-five pages of the book are devoted to the uses of gold and silver in the arts. Both volumes are supplied with a complete table of contents, but suffer from the absence of indexes.

The Telephone Service: its Past, its Present, and its Future. By H. L. Webb. Pp. 118. (London: Whittaker and Co., 1904.) Price 1s. net.

AN interesting description of the general working of the modern city telephone system is given in the pages of this book. No attempt is made to describe the power plant of the modern telephone exchange, or the details of other parts of the machinery by which an efficient telephone service is maintained, but the general principles of this means of communication are clearly explained, and suggested developments of telephone policy in Great Britain are discussed. Every subscriber who reads the book will be given an intelligent and tolerant view of the telephone service.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Magnetic Disturbances and Navigation.

CAN the compasses of modern ships be influenced by magnetic disturbances to such a degree as to imperil navigation? The disaster which on the morning of June 28 befell the Danish s.s. *Norge*, and by which about 600 lives were lost, ought, in the opinion of the present writer, to bring this question to the front. The course of the ship should take her about 25 miles south of Rockall. The last observations, by which position, deviation, and the absence of current were ascertained, were made only twelve hours before the ship struck, and showed nothing extraordinary. It seems impossible to explain the discrepancy between the real position and that of the reckoning on the morning of June 28 without assuming a sudden and considerable alteration of the deviation on the compass.

This view is supported by communications, called forth by the disaster, from two captains, who have, or at any rate think they have, directly observed such alterations. The communications run as follows:—

(1) "A few years ago I (Captain Hveysel, s.s. *L. H. Carl*) was on a voyage from the United States of America to Denmark, following the great circle from Newfoundland to Pentland Firth. About 200 miles west of Rockall I had the position at noon accurately determined by observations of the sun, but as the sky was clear in the dusk, I determined anew the latitude, as well as the longitude, by stellar observations, and found to my astonishment that the ship had gone forward in a direction about 1 point more southerly than calculated according to the reckoning. By observation of the pole star it was in fact ascertained that both the compasses of the ship had acquired a hitherto unknown easterly deviation of 10° to 11°. The weather was fine, but a faint northern light was observed, which I supposed to be the cause of the magnetic disturbance. The course was shaped in accordance with the new deviation, but I continued to take the bearings of the pole star, and towards midnight the compasses were observed to return to their normal deviation, while the aurora disappeared."

(2) "I, Captain F. W. Horner, master of the s.s. *Elixir* of West Hartlepool, while on a voyage from Port Inglis, Florida, to Linhamn, Sweden, between noon June 24 and noon June 25, in the vicinity of the Island of Rockall, found by observation of the sun that the deviation on the compasses had changed 9°, whereby my ship had gone 25 miles out of her course to the north. I was steering to pass 20 miles north of Rockall, and found by observation at noon June 25 that I had passed 45 miles north of it. After passing through the Pentland Firth the compasses again returned to normal."

This last observation has a special interest as relating to the immediate vicinity of Rockall, and to about the same time as the shipwreck of the s.s. *Norge*. Can any of your readers furnish facts of a similar nature?

So far as I have been able to ascertain, disturbances of the declination needle of like duration and intensity are completely unknown, but, to my mind at least, compasses, mounted in steel ships and compensated by powerful magnets, cannot be directly comparable to the needles of a magnetic observatory. Is it possible to explain such temporary deviations of ships' compasses, as appear to have been observed in the cases related above, from the known variations of the earth's magnetism?

AUGUST KROGH.

The Physiological Laboratory, Copenhagen University.

The Great Red Spot on Jupiter.

OWING to very ill-health, I have not been able to make observations of Jupiter during the last few weeks, but have been interested in receiving the results of some other observers. It appears that the great red spot is rapidly accelerating its motion, so that its longitude is decreasing, and with a continuation of this behaviour the spot will ultimately correspond with the position of the zero meridian of system ii. of Crommelin's ephemerides. The present longitude of the marking is about 25°, which is the same as it was in the summer of 1898, so that the mean period of rotation during the last six years has been identical with the rate of system ii., viz. 9h. 55m. 40·63s.

The variations in the velocity of the spot during the past few years have exhibited a curious oscillation, and it will be important to watch the future developments of the object. It would be interesting to see in NATURE during ensuing months some reports from observers as to whether this singularly durable marking maintains its present rapid westerly drift.

W. F. DENNING.

Bristol, September 12.

THE OLDER CIVILISATION OF GREECE: A PREHISTORIC SEA-POWER.[1]

READERS of the articles on the "Older Civilisation of Greece" which have from time to time appeared in the columns of NATURE will remember that the archæological labours of Mr. Arthur J. Evans, F.R.S., Prof. Ludovico Halbherr, Mr. D. G. Hogarth, and Mr. R. C. Bosanquet (not to mention their assistants, of whom Dr. Duncan Mackenzie and Prof. Luigi Pernier are the most distinguished) in the island of Crete have succeeded in disinterring for modern science the remains of an ancient civilisation as highly developed as the contemporary cultures of Egypt and Babylonia, and possibly as old; in any case a thousand years older than the civilisation of Greece which we have learnt to know at our schools and academies—the Greek civilisation of the schoolmasters and the sculptors. Of this prehistoric civilisation (for prehistoric it still remains, since we cannot yet read its written records) the first remains were found by the famous Schliemann at Mycenæ and Tiryns, hence the use of the term "Mycenæan" to describe it. The excavations in Crete have of late years very considerably modified our conceptions of its character; we see now that the chief seat of its development was not the continent of Greece, but the great island of Crete, and that the two most important remains of its Cretan phase were the great stone palaces of Knossos and Phaistos, which have been excavated by Dr. Evans and Prof. Halbherr respectively.

Now it is evident that the whole Mycenæan civilisation did not pass away without leaving some trace of its greatness and power upon the minds of the semi-barbarous tribes from the north who overthrew it, and afterwards built up the renascent "classical" culture of Greece upon its ruins, just as the English built up the modern renascent Roman civilisation of England on the ruins of the Romano-British culture which they destroyed. Just as traditions of the greatness of the Romans remained in the minds of the English, so, but to a much greater extent, traditions of their "Pelasgian" forerunners remained in the minds of the later Greeks and combined with their own "Aryan" tales to form the legendary history of early Greece. A considerable proportion of the Greek legends—the Wars of Troy and of the Seven against Thebes, the stories of the Atridæ and of the Minyæ, &c.—are undoubtedly altered reminiscences of the prehistoric period of high civilisation to which the remains discovered at Mycenæ, at Orchomenos, at Knossos, and at Phaistos belong. Among these legends, which certainly contain a substratum of historical truth, those of the Thalassocracy of the Cretans under the sway of the great and wise Minos are the most important. It is certain that the palace discovered by Mr. Evans at Knossos is the veritable Labyrinth of the Minotaur; one may believe in the Labyrinth without being accused of also believing in the Minotaur, and if one believes in the Labyrinth one also believes in the magnificence and power of its builders, whether their names be Minos and Dædalus or not. Probably their names were not really in the least like Minos or Dædalus, but it is evident that these appellations signify, the one the powerful prehistoric dynasty of Knossos, the other the skilled craftsmen who made for them the beautiful works of art which we can admire in the Museum of Candia, and which are photographically reproduced in the pages of the "Annual of the British School at Athens."

The most characteristic feature of the Knossian or "Minoan" power in legend is the fact that it was a sea-power. This is always insisted upon. Cretans raid the Attic coast, found colonies in Sicily and at Miletus, and so on. A power of the calibre of that which is revealed to us by the Cretan excavations can never have confined its operations to the isle of Crete alone. And the evidence of over-sea connections, with Egypt and with the continent of Greece, is so strong that there can be little doubt that the legends are right, and that Minoan Crete held a thalassocracy, was a great sea-power. Sea-power means the foundation of colonies, and apparently Minoan Crete was no exception to this rule. It may be that the coast settlement of Paláikastro, beyond Sitía at the extreme eastern end of the island, was a Minoan colony established on the non-Minoan, possibly hostile, shore of the Eteokretans, though it is only fair to say that Mr. Bosanquet is not in favour of the theory of the predominantly non-Minoan character of the Sitía country in Minoan days. At Phylakopi, in the island of Melos, the nearest of the Cyclades to Crete, has been

Fig. 1.—Shrine of snake-goddess with marble cross as central cult object. Conjectural arrangement. (From "The Annual of the British School at Athens.")

[1] "The Annual of the British School at Athens," No. ix., 1903-4. Pp. x+422, and Plates. (London: Macmillan and Co., Ltd.) Price 17s. net. "Excavations at Phylakopi in Melos." Hellenic Society Supplementary Paper, No. 4. Pp. xv+280, and Plates. (London: Macmillan and Co., Ltd.) Price 30s. net.

discovered a strongly walled settlement of indubitably "Minoan" character, superimposed upon the ruins of earlier, no doubt native, towns; that this was a Cretan over-sea colony there can be little doubt.

The excavations which have revealed to us these striking confirmations of the Greek legend of the Minoan thalassocracy have been carried out by the British School at Athens during the last eight years under the control of its successive directors, Mr. Cecil Smith, the present keeper of Greek and Roman antiquities in the British Museum, Mr. D. G. Hogarth, and Mr. R. C. Bosanquet. The energy of the British School at Phylakopi and Paláikastro, combined with the remarkable results achieved by Dr. Arthur Evans at Knossos, has largely helped to win for England that foremost position in practical Greek archæology which she holds at present. For not even our friendly rivals in Germany can for a moment dispute the fact that England and Italy are *facile principes* in Greek archæology at the present day. Germany is only tardily following in our footsteps with the excavations at Orchomenos, and has not even yet secured for herself a site for exploration in Crete, while France seems hopelessly wedded to classical traditions, and has no thought for the extraordinary prehistoric civilisation, twin-sister it would almost seem to that of Egypt, which is revealing itself in Crete.

FIG. 2.—Two of the ancient crania exhumed at Hagios Nikolaos. (From "The Annual of the British School at Athens.")

The chief publication of the year dealing with these English discoveries is, as usual, the "Annual of the British School at Athens." The volume for 1904 contains Dr. A. J. Evans's annual report on Knossos, and Mr. Bosanquet's report on Paláikastro. Dr. Evans tells us how his work in the Labyrinth still goes on, and seems to be no nearer completion. Discoveries of the highest historical importance still continue to be made. An extraordinary light has been thrown upon the religion of Pelasgian Greece by the discovery of the images of a snake-goddess by Miss Boyd (American excavations) at Gourniá, half-way between Knossos and Paláikastro, and by Dr. Evans at Knossos, in the latter case in conjunction with a *cross* as central cult-object. What is to be made of this? Any day's work, any turn of the spade, may turn up something extraordinary. And these same snake-goddesses of Knossos are made of a fine varicoloured glazed faïence, like that of Egypt. That the Minoans derived this idea from Egypt is certain. Other objects of the same glaze were found, shells especially; the colour of the glaze of many of these shells is that of the rare Egyptian glazed faïence of the dynasties of the Old Empire, between B.C. 4000 and B.C. 2000. This typical colour is a light blue, radically different from the shining dark blue of the twelfth dynasty or the beautiful colours of the blue glazed pottery of the eighteenth. It is not, however, very different from the light blue of the twenty-sixth dynasty. The reason is not far to seek; the twenty-sixth dynasty artists archaised here as in greater matters; they imitated the colour of the earliest faïence. The date of the Minoan palace of Knossos is between the epoch of the twelfth dynasty and that of the eighteenth; the date of the old light blue faïence is earlier, between B.C. 4000 and the twelfth dynasty. It was this faïence that the Minoan potters imitated. The conclusion as to the date at which Greek civilisation first began to borrow ideas from that of Egypt may seem extraordinary; but Mr. Evans's diggings at Knossos have already produced so many extraordinary things that we are prepared for more.

We do not expect the same remarkable discoveries from Mr. Bosanquet's diggings at Paláikastro. It is a poorer site, and it is not the Labyrinth of Minos. Enough has, however, been found more than to maintain the interest of former years of excavation, and there is little doubt that here was a Minoan settlement like that of Phylakopi. Two new features at Paláikastro are the remains of primitive burials from the cave of Hagios Nikólaos and the remarkable ossuaries at the sites of Roussolakkos and Patema, and the great hoard of votive terracottas found by Messrs. Myres and Currelly on the hill of

FIG. 3.—External face of great wall, showing revetment on the right and bastion in the distance. (From "Excavations at Phylakopi in Melos.")

Petsofà or Tsofàs, south of Paláikastro. The skeletons are usually in the contracted position characteristic of the Neolithic race of the Mediterranean; they show small stature (average 1.625 m.) and dolichocephalic head-form. Mr. Duckworth, who describes them, says "it seems that the early Cretans anticipated in head-

form and stature the proportions assigned to the 'Mediterranean race' [of Sergi], and thus can be described as the earliest known representatives of that race" (p. 354). It is, however, confusing to speak of the Paláikastro people as "anticipating" the Mediterraneans in any way; the Paláikastro skulls, though no doubt a few hundred years older than "those discovered at Zakro [on the coast south of Paláikastro] and described by Boyd Dawkins, and those from Erganos [a Mycenæan site in a valley running up from the Pediada plain into the Lasíthi mountain-system near the Aphendis Sarakinos] described by Sergi" (p. 353), are of Bronze age date, while the Neolithic Mediterraneans belong to Sergi's race as much as the Mycenæans; the Paláikastro people *were* "Mediterraneans" (as Mr. Duckworth says on p. 349)—they did not anticipate them.

The Petsofà find of votive terracottas is paralleled by the very similar pocket of votive female figures and models of female breasts, &c., phalli, and figures of cows, of red pottery and blue glazed faïence, found by Prof. Naville and myself during the past season in the eighteenth dynasty dust-heap of Queen Hatshepsu's temple at Deir-el-Bahari, in Egypt; a number of these votive figures were exhibited at the annual show of the Egypt Exploration Fund at University College, Gower Street, in July.

The pottery from Paláikastro is discussed by Mr. R. M. Dawkins, who publishes a very fine "filler-vase" (p. 311) of the well known Mycenæan type. For a parallel Mr. Dawkins refers to a representation of a vase in the tomb of Rekhmara, at Thebes in Egypt, published by Mr. W. M. Müller in his "Asien und Europa," p. 340, and by me in "The Oldest Civilization of Greece," frontispiece. This representation of the vase in question, for which not Mr. Müller, but the great Champollion is responsible, is, however, inaccurate. Mr. Dawkins would have found a better parallel from the tomb of Rekhmara in last year's "Annual of the British School," p. 171. Mr. Dawkins also contributes a most interesting account of a visit to the rather remote island of Karpathos, between Crete and Rhodes, which should be of interest to geographers and anthropologists. To anybody who has seen them from the Eteokretan heights above Sitía, or from the shores of Grandes Bay by which Paláikastro lies, the islands of Kasos and Karpathos offer a most alluring invitation; but it is not everybody who can spare the time to accept it. Mr. Dawkins has been able to do so, and is lucky.

The excavations at Phylakopi, in Melos, were conducted by the School before those at Paláikastro, in Crete, were begun. They are not yet completed, the work at Paláikastro having been taken up with the idea of returning to Phylakopi at some future date. It is to be hoped that this aspiration will be fulfilled, for Phylakopi is among the most interesting of "Mycenæan" sites. The excavations were carried out from 1896 to 1899, Mr. Cecil Smith being in command during the first two years, Mr. Hogarth in the third, and Mr. Mackenzie, now Mr. Evans's assistant at Knossos, in the fourth. Mr. Mackenzie was present during the whole four seasons, thus supplying the "element of continuity" in the excavations. Each of these gentlemen has contributed his quotum to the combined work which has been issued for the school by the Society for the Promotion of Hellenic Studies under the direction of an editorial committee, composed of Mr. Bosanquet, Mr. E. A. Gardner, and Mr. G. F. Hill, of the British Museum. Messrs. Arthur Evans, Bosanquet, G. C. Edgar, F. D. Atkinson, and F. B. Welch have also contributed to the volume.

The result is a remarkably valuable and well got-up book, with an extremely good series of illustrations. Among articles which are all of equal value and interest it is invidious to direct special attention to any in particular, but while Mr. Bosanquet's on the wall-paintings and Mr. Edgar's on the pottery are of special interest to "Mycenæologists," those of Mr. Bosanquet on the early Ægean trade in obsidian, which seems to have radiated from Melos, and of Mr. Mackenzie on the general historical relations of the successive settlements, especially in connection with the Minoan culture, which Mr. Mackenzie has had such unequalled opportunities of observing in the course of his work with Mr. Evans at Knossos, will be of more general interest, and should be carefully noted by all students of early culture-development. The famous fresco of the flying-fish, the most remarkable example of Mycenæan art found at Phylakopi, is published in colour on Plate iii.; as a delineation of the animal it is remarkably accurate, and as a design most admirable.

Fig. 4.—The site from north-east. Beach of boulders in the foreground. (From "Excavations at Phylakopi in Melos.")

Enough has been said to show that this year's record of the annual progress of the discovery of the older civilisation of Greece has in no way fallen behind its predecessors in interest. H. R. Hall.

NOTES.

On Saturday last, September 10, the *Discovery* arrived at Portsmouth with the members of the British Antarctic Expedition. On Sunday Captain Scott received a telegram from the King offering His Majesty's congratulations on the success and safe return of the explorers. The King has directed that a new medal for service in the Polar regions shall be struck and granted to the officers and crew of the *Discovery* in recognition of the successful accomplishment of their enterprise. Commander Scott has been promoted to the rank of captain in the Royal Navy; and the nation's thanks are due to him, the officers, scientific staff, and crew of the *Discovery* for the successful way in which they have maintained the credit of our country in the records of geographical discovery. The first news of the expedition after the departure of the *Discovery* from New Zealand in

December, 1901, was brought by the relief ship *Morning*, which arrived at Lyttelton in March, 1903. From the information then received, described in NATURE of April 2, 1903 (vol. lxvii. p. 516), it was evident that the expedition had already achieved great success, both in the way of exploration and of scientific observation. Further details of the first year's work of the expedition, especially with regard to the great southern ice barrier and the nature of the lands discovered, are contained in Captain Scott's official report communicated to the presidents of the Royal and the Royal Geographical Societies, summarised in these columns on July 30, 1903 (vol. lxviii. p. 307). Upon the return of the *Discovery* to Lyttelton at the beginning of last April, accompanied by the relief ships *Morning* and *Terra Nova*, it became known that many specimens of great scientific interest had been collected, including fossil remains of dicotyledonous plants from an altitude of 8000 feet. The material thus accumulated, as well as the continuous magnetic records and other observations in terrestrial physics, will be of the greatest value to science, and the study of it will engage the attention of naturalists and physicists for some time to come. The specimens brought home include the emperor penguin and other rare Arctic birds and their eggs, geological and other specimens, a large number of photographs of Antarctic scenes, some of which were taken by moonlight; and a set of coloured drawings of parhelions observed when the sun rose.

THE report of the council of the Society of Chemical Industry was presented to the annual general meeting opened in New York on Thursday, September 8. From this report we learn that the number of members on the register on July 31 was 4134, as compared with 3050 at the previous annual meeting. The council urges that Government, through a department, should be in closer touch with commerce and industries. In Germany the functions of the Ministry of Commerce comprise the control of "all matters affecting handicrafts," and to it, as a consultative body, is attached the technical committee for industry, which studies the scientific progress of industries, and keeps the minister in touch with them. America has recently established a department of commerce and labour, and France has had a Minister of Commerce for some years. The council two years ago appointed a committee to cooperate with members of Parliament and others who are in favour of this reform. The council has given its support to a petition asking the Treasury that the National Physical Laboratory may be placed in a position to do its important international work by means of a grant for capital expenditure and an increased annual subvention. Among the more important researches carried out by the laboratory during the past year may be mentioned those on pure iron-carbon alloys, certain nickel-steel alloys, mercury standards of resistance, a comparison of thermometers up to 1100° C., and measurements of the specific heat of superheated steam up to a pressure of 200 lb. to the square inch. The society's medal, founded in 1896, and awarded by the council once in every two years for conspicuous service rendered to applied chemistry by research, discovery, invention, or improvements in processes, has this year been awarded to Prof. Ira Remsen, president of the Johns Hopkins University of Baltimore.

A LARGE party of members of the Liége Association of Engineers, the leading technical society in Belgium, visited London on September 12 and 13. On September 12 they proceeded to Teddington and visited the National Physical Laboratory, where they were received by Sir Edward Carbutt on behalf of the executive committee. On September 13 they were entertained at dinner at the Hotel Cecil by the Iron and Steel Institute. Mr. E. Windsor Richards, who was president when the institute visited Liége in 1894, occupied the chair, and an eloquent speech of welcome was delivered by Sir James Kitson, past-president of the Iron and Steel Institute, and ably responded to by Mr. Jules Magery, the president of the Belgian society.

THE second International Philosophical Congress was held at the University of Geneva under the presidency of M. Ernest Naville on September 4–8, and was attended by 500 members, representative of every school of philosophic thought in Europe. We learn from the *Times* that the following papers were read:—Prof. Boutroux, of l'Institut Paris, on the *rôle* of the history of philosophy in the study of philosophy; Profs. Stein (of the University of Bern) and Gourd (of the University of Geneva), the definition of philosophy; Prof. Windelband (of Heidelberg), the present task of logic and philosophical inquiry in relation to natural science and culture; Profs. Vifredo Pareto (of Lausanne) and De Greef (of Brussels), the individual and society; and Profs. Reinke (of Kiel) and Giard (of Paris), neovitalism and finality in biology. At the sectional meetings the subjects under discussion were the history of philosophy, general philosophy and psychology, applied philosophy, logic and philosophy of the sciences, and history of the sciences.

IN connection with the reception given by the United States Naval Observatory to the eighth International Geographic Congress at Washington on Thursday, September 8, a special set of time signals was sent over the Western Union Telegraph Company's system from Washington to England for transmission over the lines of the Government, the Eastern Telegraph Company, and the Great Northern and Western Telegraph Companies to observatories in various parts of the world. The object of the signals was to mark the actual passing of midnight at Washington, and accompanying the signals was the following message:—"The eighth International Geographic Congress now in session in Washington sends with this midnight signal its greeting to the nations of the world through the courtesy of the various telegraph and cable companies." The *Times* states that the observatories at the following places sent complimentary responses in most cases immediately on receipt of the foregoing messages and signals:—Greenwich, Pulkowa (Russia), Helsingfors, Madrid, Lisbon, Rome, Madras, Mauritius, Cape Town, Melbourne, Adelaide, Sydney, Wellington, N.Z., Rio de Janeiro, and Cocos. It was hoped that the signals would have a favourable influence on the movement to secure the universal adoption of standard time, based on the meridian of Greenwich.

Science announces that the Department of Agriculture at Washington is making definite arrangements concerning the work which will be carried on with the Guatemalan ants found by Mr. O. F. Cook in Guatemala to kill the cotton boll weevil. Mr. Cook has authority under the chief of the Bureau of Entomology to carry to completion the study of the life-history of the Guatemalan ant, and of such other species of ants as may be involved, in order properly to understand the life-history of this species. He will also direct and superintend the further introduction of the *kelep* ant from Guatemala if the same is deemed necessary, and will supervise and carry out the work connected with the colonisation of the ant in the southern United States.

AN exceptional rainfall in Cuba is reported in the *Times* of September 10 as having occurred on June 13. Mr. W. A. Wilson, of the Public Works Office at Santiago,

writes that the storm lasted for three hours, and was accompanied with almost continuous thunder and lightning, and he estimates that at least 12 inches of rain fell during that time. Bridges and houses were washed away, and about a hundred lives were lost in that locality. The storm extended over a considerable area, probably 200 to 300 square miles, and the Guaninicum and Platanillo Rivers each rose 33 feet. Mr. Wilson gauged the fall for an hour and a half, during which time nearly 7 inches were measured. Santiago is a station of the U.S. Weather Bureau; we shall therefore hope to receive a fuller account of the storm. In looking through their last published report (1902–3), we do not find any figures equalling the above, but in Symons's "British Rainfall for 100?" 3·50 inches are recorded in one hour. The most noteworthy facts appear to be the duration of the great intensity of the fall and the large area over which the storm occurred.

The Meteorological Council has recently issued part I. of "Climatological Observations at Colonial and Foreign Stations." In the preface Dr. W. N. Shaw states that the council has contemplated for some time the issue of summaries of the observations which they receive from the Foreign Office, the Colonial Office, or directly from the observers in various British colonies and dependencies, but that it has been unable hitherto to carry out the preparation of the observations for the press. Mr. E. G. Ravenstein, who was chairman of a committee appointed by the British Association at the Cardiff meeting in 1891 for the collection and discussion of observations from tropical Africa, has, however, been good enough to put together the observations for a large number of stations, and to superintend the preparation of the summaries. These have now been issued by the Meteorological Council for the years 1900–2, with summaries for previous years, and form a very valuable contribution to the meteorology of that part of the world. The observations refer chiefly to stations in the Egyptian Sudan, British East and Central Africa, and Rhodesia. The volume is accompanied by useful sketch maps showing the positions of the various stations.

Dr. F. M. Exner contributed a useful paper to the Vienna Academy of Sciences (*Sitzb.*, Heft x., 1903) on a relation between the distribution of air pressure and amount of cloud, based on an examination of the mean values of twenty years' observations. The question to be solved was with what distribution of pressure, with a west wind of given strength, has Vienna a certain amount of cloud or rainfall. The result of the investigation showed that when the air flowed from an area of steep barometric gradients to one of slight gradients, it was accompanied by bad weather, and *vice versâ*. The reason is that in the first case more air flows towards the locality than flows away from it horizontally, so that a portion of it finds its way to the upper strata, while in the second case the opposite occurs. The same rule would apply not only to a west wind, but would hold good for wind from any quarter. The paper is illustrated by a series of charts.

Messrs. S. Hirzel, of Leipzig, announce a new publication bearing the title *Jahrbuch der Radioaktivität und Elektronik,* to be edited by Dr. J. Stark, of Göttingen. Each volume will be issued in four quarterly parts.

The mathematical and scientific section of the Imperial Academy of Sciences, Vienna, announces a prize of 2000 krone to be awarded for the best thesis embodying "an improvement in our knowledge of the hysteresis of dielectrics." The competition will close on December 31, 1906.

No. 16 of the *Physikalische Zeitschrift* contains several papers dealing with radio-activity. F. Paschen shows that when the kathode rays produced by radium are caused to impinge from above upon a photographic plate placed film downwards on a small sheet of platinum, an intense blackening is produced in the negative which corresponds in outline with the metal. That this effect is due to a secondary radiation, and is not caused merely by reflection of the kathode rays from the platinum, appears to be proved by the fact that when these rays are directly transmitted through a sufficiently thin plate of the metal, the darkening beneath the metallic film is much more intense than elsewhere. It is the γ rays which seem to be mainly responsible for the secondary radiation. Mr. H. A. Bumstead has carefully investigated the nature of the radio-activity induced in a negatively charged wire by exposure to the atmosphere. He concludes that the atmosphere contains principally the emanation of radium, but that the thorium emanation is also present to an extent varying largely with conditions such as the temperature and stillness of the air. On the other hand, Dr. E. F. Burton considers that the radio-active emanation which is evolved on heating raw petroleum is due solely to radium, and that a small quantity of radium itself is present in the oil. Miss C. Böhm-Wendt describes measurements which show that the amount of ionisation produced by polonium in different gases is independent of the nature of the gas. In this respect, therefore, polonium resembles radium.

It has long been a controversial question whether by the action of heat alone the line spectrum of gases can be produced. In the July number of the *Atti dei Lincei* R. Nasini and F. Anderlini endeavour to give a definite answer to the problem. On subjecting the vapour of iodine to a high temperature in a carbon tube heated in an electric furnace, they found that at slightly above 1000° an emission spectrum is produced which is the inverse of the usual absorption spectrum of iodine vapour. Similarly nitrogen at temperatures above 3000° gives an emission spectrum in which the principal lines characteristic of the element are visible. Under the conditions used it is probable that electrical influences were excluded, and that the spectra obtained were due solely to the high temperature employed. In the same number of the *Atti* L. Vanzetti has studied the electrolysis of glutaric acid in order to decide whether the dibasic aliphatic acids are capable of being converted in this way into polymethylene hydrocarbons, and whether the synthesis of a closed ring can thus be effected. The acid gave, however, only ordinary propylene, not a trace of trimethylene being formed.

We have received copies of two interim reports issued by the Engineering Standards Committee. One of the publications contains British standard tables of copper conductors and thicknesses of dielectric; the other includes the British standard specification for tubular tramway poles. The tables and specification are to be regarded as final, and they will be embodied in the final report of the Engineering Standards Committee, which will combine all specifications. The tables dealing with copper conductors give the British standard sizes of stranded conductors for electric supply, and separate tables are concerned respectively with large, intermediate, and small sizes. Other tables provide British standard radial thicknesses for jute or paper dielectric, lead and armour, for underground cables, and British standard radial thicknesses for rubber dielectric, for lead sheathing and armouring. The specification for tramway poles gives full particulars as to construction, length, length of section, outside diameters, minimum thickness, &c., and also as to

what tests should be applied to the poles. As the preface to the specification says, a standard specification having now been arrived at as the result of the joint labours of the committee and the makers, it is hoped that, in future, the standards recommended by the committee will be universally adopted by all engineers engaged in designing and installing electrical tramways throughout the British Empire.

THE contents of the June number of the *American Naturalist* are chiefly biographical and botanical, Dr. R. T. Jackson contributing an account (with a portrait) of the life and work of the late C. E. Beecher, while Dr. B. M. Davis continues his studies on the plant-cell, and Mr. F. C. Lucas illustrates diagrammatically the range of variation displayed by the blossoms of the common cone-flower (*Rudbeckia hirta*).

THE entomological division of the Biological Laboratory of Manila has issued an illustrated *Bulletin* of fifty-eight pages, by Mr. C. S. Banks, the Government entomologist, on insects affecting the cacao, intended specially for the benefit of cultivators of that valuable crop in the Philippines. Every part of the cacao plant, from the root to the fruit, has its particular enemies, black ants and cicadas attacking the roots, while beetle-grubs bore into the trunk, and various Coccidæ and aphides damage the fruit. Fortunately the ravages of certain of these scourges are somewhat checked by other insects which prey upon the species damaging the cacao. Much further work is required before the whole history of cacao-hunting insects can be known, and the best means of checking their ravages devised.

WE have received from the publishers, Messrs. Asher and Co., Bedford Street, W.C., a specimen of a series of fifty coloured biological diagrams, reproduced from the German issue of Messrs. Schröder and Kulls, but with the explanatory legends in English. The plates are 34 by 42 inches in size, are printed in from six to eight colours, and are sold at 3s. each. The one with which we have been favoured illustrates the structure and life-history of the cockchafer, with comparative studies of other beetles. It is admirably adapted for school purposes. Judging from reduced photographic reproductions of other diagrams, we think those devoted to invertebrates are superior to those illustrative of mammals, so far as drawing is concerned; but this is a common feature in German zoological art.

IN the September issue of the *Quarterly Journal of Microscopical Science* Prof. E. R. Lankester re-publishes his valuable and profusely illustrated article on the structure and classification of the Arachnida from the tenth edition of the "Encyclopædia Britannica." One of the points emphasised in this communication is the affinity of the king-crab (Limulus) and the trilobites to the Arachnida rather than to the Crustacea; and in summarising the evidence for the arachnid nature of the former, the author alludes to the interesting discovery by Mr. Pocock of a rudiment of the seventh segment of the scorpion-limb in Limulus, thus bringing the two genera very closely into line. Another interesting feature to which special attention is directed is the mode of evolution of the "lung-book" of the scorpion from the "gill-book" of the king-crab, which appears to be a unique phenomenon. Among the other contents of the number in question may be mentioned two papers by Prof. W. B. Benham on new worms from New Zealand, and one by Dr. H. J. Hansen on new parasitic copepod crustaceans.

PARTS iii. and iv. of vol. xlv. of *Smithsonian Miscellaneous Contributions* contain an important paper by Mr. M. W. Lyon on the hares, rabbits, and picas, illustrated by a number of figures of their comparative osteology and dentition. Needless to say, the old Linnean genus Lepus is much subdivided, and, unfortunately, the generic and subgeneric divisions adopted by the author by no means coincide with those proposed a few years ago by Dr. Forsyth Major in the *Transactions* of the Linnean Society—a notable divergence being the generic separation of the South African thick-tailed hare from the rabbit. Owing to the complexity of the classification adopted, some of the species of Leporidæ cannot at present be definitely placed, and are therefore, strictly speaking, without subgeneric names. This will, however, be remedied in the course of time, and there is no doubt whatever that the present memoir—whether or no its proposed scheme of classification be adopted in its entirety—is an important contribution towards the right understanding of an exceedingly difficult group of mammals.

A SERIES of Jurassic ammonites from Echizen and Nagato in Japan has been described and figured by Prof. Matajiro Yokoyama (*Journ.* Coll. Sci. Tokyo, vol. xix., art. 20). The strata in the province of Echizen comprise a series of shales and sandstones, mostly of fresh-water origin, but divisible into a Lower or Ammonite bed, a Middle or Plant bed, and an Upper or Cyrena bed. The Ammonites include several new species of Perisphinctes, all more or less allied to foreign Lower Oxfordian forms, and one species of Oppelia, which exhibits a distant relationship to *Oppelia nobilis* of the Tithonian. The strata which have yielded Ammonites in Nagato consist of clay-slates, so that the fossils are much compressed. Species of Hildoceras, one of which is near to *Am. Levisoni* (of Wright); of Harpoceras, near to *A. lythensis* and *A. exaratus*; of Cœloceras, near to *A. fibulatus*; and of Dactylioceras, near to *A. annulatus*, indicate that the Nagato slates belong to the Lias, and probably to the upper part of it.

SOME useful hints on the practical development of a farm wood-lot are given in a *Bulletin* of the Hatch Experiment Station of the Massachusetts Agricultural College, issued last May. The products required in this particular case were fire-wood, fencing posts, and lumber for making fruit boxes, besides which some poles and more valuable timber were obtained. The writer, Mr. F. A. Waugh, recommends larch for posts and chestnut and hickory for lumber. The illustrations added are numerous and well chosen.

THE formation of root-hairs in the vascular cryptogams and flowering plants has been studied by Mr. R. G. Leavitt, and his account, which is published in the *Proceedings* of the Boston Society of Naturalists (April), contains several points of interest. In the case of lycopods, horsetails, and a few ferns, the trichoblasts are determinate, but in all dicotyledons, except the Nymphæaceæ and most of the true ferns, root-hairs may arise from any external cell. Of monocotyledons, the Liliifloræ and Spadicifloræ generally conform to the latter type, but in the Helobieæ, Glumifloræ, and Enantioblastæ the root-hairs develop from definite cells.

THE annual report of the Botanical Department of Trinidad for the year ending March 31 has been received. The superintendent, Mr. J. H. Hart, states that he has succeeded in raising seedling sugar canes in Trinidad which compare with the best varieties obtained in Barbados, Antigua, and elsewhere. It appears that owing to the practice of cutting the plants annually in May, the seed production and the sucrose content are reduced, so that the experiment will be tried of allowing plants for seed to remain over for a longer period. The plantations of

Balata, *Mimusops globosa*, and of the imported timber trees, Honduras mahogany and African mahogany, *Kasya senegalensis*, are growing freely

FOR the forthcoming new edition of the "Imperial Gazetteer of India," Sir J. D. Hooker has written a chapter on the flora of India, which is prefaced by an introductory summary. With the authority of the Secretary of State for India, this chapter has been issued in an advanced form, and the summary is reprinted in the *Journal of Botany* (August). In the same number an account will be found of certain changes which will be proposed at the forthcoming congress of botanists to be held at Vienna in June, 1905, in connection with the rules which govern botanical nomenclature. The three lists of suggestions here given take the form of alterations in, or additions to, the Paris code, and have been drafted respectively by British botanists of the British Museum, American botanists of the Gray Herbarium, and a group of Italian botanists.

THE latest addition to the Manueli Hoepli is a handbook dealing with artisan dwellings, by the engineer Effren Magrini, of Turin. In the same series Dr. Guido Sandrinelli has issued a new and completely revised edition of the manual of the late Pietro Gallizia on strength of materials and applied elasticity. It deals with calculations of strains and stresses in beams and other structures, and allied problems of use to the practical engineer.

No. 5 of the *Bulletin* of the Belgium Academy of Sciences contains an account by A. de Hemptinne of a remarkable electrolytic synthesis of stearic acid from oleic acid. This acid, when subjected in an atmosphere of hydrogen to the discharge of a Tesla transformer, combines with the gas to form principally stearic acid. In No. 6 of the *Bulletin* is a description of the preparation and properties of a number of fluorine-substituted amines. These substances are remarkable because of their extraordinary stability as compared with the corresponding chloro- and bromo-derivatives, which, as a rule, decompose rapidly at the ordinary temperature.

To the *Smithsonian Miscellaneous Collections* (vol. xlv., parts iii. and iv.) Prof. F. A. Lucas contributes an account of a nearly perfect skeleton of a pavement-toothed iguanodon (Trachodon or Claosaurus). The edentulous predentary and premandibular bones of the iguanodont dinosaurs are considered by the author to have been sheathed in horn, and thus to have formed a beak adapted for nipping off the branches or herbage on which these reptiles fed. Among other contributors to the same part are also Messrs. Jordan and Snyder, who describe several new deep-water fishes from Japan. These include a shark of the genus Pristiurus, as well as one of Pseudotriacis, and likewise a new genus, Trismegistus, allied to Liparis. *Trismegistus owstoni*, as the third of these new species is called, is certainly a very remarkable fish, somewhat like a sole in shape, although, of course, bilaterally symmetrical, with the skin dotted with prickles supported on broad bases, so as to recall inverted drawing-pins.

IN the August number of the *American Journal of Science* Mr. Bertram B. Boltwood records observations which indicate that the quantities of radium present in several uranium minerals, which have been examined, are directly proportional to the quantities of uranium contained in the minerals. This is perhaps to be regarded as experimental evidence in favour of the suggestion that radium is formed by the breaking down of the uranium atom.

IN the August issue of the *Annales de Chimie et de Physique* is a contribution by Messrs. Moissan and Rigaut on the use of metallic calcium in the preparation of argon. It is shown that the last traces of nitrogen, which are not so easily removed by a heated mixture of lime and metallic magnesium, are readily absorbed by passage of the gas over a small quantity of metallic calcium. An apparatus is described in which argon can be continuously produced at the rate of a litre every twelve hours.

SOME interesting experiments relating to the electrolytic reduction of carbonic acid are described by Messrs. Coehn and Jahn in the *Berichte der deutschen chemischen Gesellschaft* (vol. xxxvii. p. 2836). The reduction cannot be effected in acid solutions or in solutions containing the normal carbonates, but takes place readily in bicarbonate solutions. From this the authors conclude that the reducing action is limited to the bicarbonate ion, and that the carbonate ion and the undissociated carbonic acid molecule are not reducible. The reduction only takes place at those electrodes at which hydrogen is discharged at a considerable over-voltage, and the product of reduction is formic acid.

WE have received a copy of the report and recommendations presented to the Pharmacopœia Committee of the General Medical Council by Prof. Wyndham R. Dunstan and Mr. H. H. Robinson with reference to the tests for the detection of arsenic in the drugs of the British Pharmacopœia. It is found that the test proposed by Mayençon and Bergeret in 1874, if performed under certain conditions, is best adapted to the purpose. This test depends on the production by arseniuretted hydrogen of a stain on paper soaked in mercuric chloride. The method possesses the advantage of requiring only such a degree of purity in the acid and zinc as is to be found in purchaseable materials, and thus avoids the special purifications involved in the Marsh-Berzelius test. The stain decided on as the standard of comparison is that given by 0·012 milligram of arsenic.

OUR ASTRONOMICAL COLUMN.

RE-DISCOVERY OF ENCKE'S COMET.—A telegram from the Kiel Centralstelle announces the re-discovery of Encke's comet at the Koenigstuhl on September 11. The position of the comet at 13h. 16·9m. (local M.T.) was

R.A. = 1h. 46m. 16s., dec. = +25° 24'.

These positions seem to be very slightly lower than the apparent positions given in the ephemeris reproduced in these columns on September 8. As this is the second comet of this year, it will be designated 1904 *b*.

DR. COMMON'S 60-INCH REFLECTOR.—In *Circular* No. 83 of the Harvard College Observatory, Prof. E. C. Pickering announces that, thanks to the generosity of an anonymous donor, who, unconditionally, gave twenty thousand dollars to the observatory, and to the intermediary services of Prof. Turner, the observatory has been able to purchase the well known 60-inch mirror which was made by the late Dr. Common.

Arrangements are being made to transport the mirror to Cambridge (Mass.) as soon as possible, and, when mounted, it will be used to complete the photometric survey of the heavens which has been so thoroughly—so far as means would permit—prosecuted at Harvard. With an instrument of this aperture it will be possible to measure the light of the very faintest stars known.

Prof. Pickering states that Mr. T. A. Common, from whom the mirror was purchased, let them have it on such favourable terms that he may fairly be regarded as having contributed a large portion of the cost.

VARIABLE STARS IN THE LARGE MAGELLANIC CLOUD.—Although the Magellanic clouds have been looked upon as centres of extraordinary physical conditions, the congregation of variable stars within their limits has hitherto remained unnoticed.

In *Circular* No. 79 of the Harvard College Observatory, however, it was announced that an examination of the Harvard photographs showed that the small cloud contained numerous variables. Consequently, an examination of the photographs of the large cloud was made, and resulted in the discovery of 152 new variable stars within its boundaries. A catalogue of these, giving their positions (for 1900·0), their magnitudes, and the magnitude-range of their light-variations, is published in No. 82 of the Harvard College Observatory *Circulars*.

All these variables have short periods, and seem to be arranged in definite groups, the most remarkable of which begins near N.G.C. 1850, and extends towards a point about one degree south of N.G.C. 2070. This group contains more than half the stars observed, and the included stars are remarkable for their faintness and for the small range of their variations.

THE SUN'S ANTI-APEX.—Mr. J. E. Gore sends the following remarks upon Prof. Kobold's study of the sun's proper motion, mentioned in last week's NATURE (p. 459):—"Prof. Kobold gives the position $A=159°·6$, $D=-54°·7$, or R.A. 10h. 38·4m., $\delta=-54°·7$, and says the point is near α Argus. (His words are, 'Der berechnete Punkt liegt am Himmel ganz in der Nähe von α Argus, der gegenüberliegende Punkt in der Nähe von δ Cephei,' *Astronomische Nachrichten*, 3961.)

"This is, however, not correct, for the position of α Argus (Canopus) is R.A. 6h. 21·8m., $\delta=-52°\ 39'$ (1900). His statement that the 'opposite point' (the apex) lies near δ Cephei is, however, correct. The point found by Prof. Kobold for the anti-apex lies a little north of the famous variable star η Argus. This point lies in the Milky Way, as stated by Prof. Kobold. The fact that most of the determinations of the position of the solar apex lie in or near the Milky Way seems to suggest that the sun may be moving in an orbit 'nearly coinciding with the plane of the Milky Way.' This was pointed out by Mr. G. C. Bompas in the *Observatory*, January, 1896."

OBSERVATIONS OF THE SOLAR SURFACE, JANUARY–MARCH.—M. Guillaume, director of the Lyons Observatory, communicated a *résumé* of his observations of the solar surface during the first three months of the present year to the Paris Academy of Sciences on August 1.

The total spotted area was less than half the amount for the previous trimestre, the observed values being 2572 and 5130 millionths respectively. This was not due, however, to the absence of spots, for the phenomena have decidedly entered upon a period of increasing activity; the solar disc has not been free of spots since September 21.

In the preceding cycle the present condition of activity obtained 1·6 years after the minimum of 1889; in the present cycle 2·0 years have elapsed since that of 1901.

During the period under discussion 77 groups of faculæ with a total area of 86·0 thousandths were recorded, instead of 64 groups and 66·0 thousandths as recorded in the previous trimestre. The faculæ were also less symmetrically arranged in regard to latitude, there being 35 groups in the southern hemisphere and 42 in the northern in place of 33 and 31 respectively (*Comptes rendus*, No. 5).

INSTRUCTIONS TO VARIABLE STAR OBSERVERS.—At a meeting of the Société astronomique de France held in 1900 it was decided to form a section for the observation of visual variable stars, and for the organisation of the section a committee was formed.

This committee now publishes, in the September *Bulletin* of the society, the first chapter of a set of very detailed instructions to variable star observers.

This first instalment contains a list of stars which are especially suitable for observations of the nature proposed, minute instructions as to the methods of observing and of recording and reducing the results, and many other hints which will be found extremely useful by anyone engaged in making visual observations of variable stars.

OBSERVATIONS OF FUNDAMENTAL STARS.—In the catalogue of 2798 zodiacal stars published by Sir David Gill in 1899, 210 of the objects named were designated "fundamental stars," but the places of only about two-thirds of these were given in Newcomb's fundamental star catalogue for 1900.

To facilitate the work of other observers, Mr. R. H. Tucker, of Lick Observatory, has just published the observed places of the remaining third in No. 3965 of the *Astronomische Nachrichten*. He gives the designation, the magnitude, the observed positions (reduced to 1900), the precessional values, and, in some cases, the proper motion in each coordinate of all the stars which are given in the zodiacal catalogue but are not mentioned in Newcomb's catalogue.

THE BRITISH ASSOCIATION.

SECTION K.

SUBSECTION, AGRICULTURE.

OPENING ADDRESS BY WILLIAM SOMERVILLE, M.A., D.SC., D.ŒC., CHAIRMAN OF THE SUBSECTION.

THE audience that I have to-day the honour of addressing may be assumed to consist of a considerable proportion of the members of the British Association, and some others, who are primarily interested in, and have themselves made appreciable contributions to, the progress of Agricultural Science. I may, therefore, take the opportunity of congratulating you on this fresh evidence of progress in the subject that you have at heart, and of offering to the British Association our thanks for the encouragement and stimulus which are associated with the formation of an agricultural subsection. Perhaps I rightly interpret your feelings when I say that for the present we are satisfied with the position attained by our subject, but that we trust to see this and other meetings demonstrating that Agricultural Science is not unworthy of further advancement.

In view of the large amount of work that lies before us during the next few days, I do not propose to intervene for long between you and the contributions to original research which we have been promised. The scope of my remarks will be limited no less by time than by the fact that it would be presumptuous in me to attempt to traverse the whole field of Agricultural Science, including, as it may be held to do, the no small compartments of Horticulture and Forestry. What I propose to do, therefore, is to confine myself to touching upon a few of the subjects that have recently been receiving attention at the hands of scientific investigators, especially abroad. I have purposely avoided discussing English work, partly because it may be assumed that we are all familiar with it, and partly because, where friends are concerned, selection is difficult.

Although Agriculture has only now been elevated to a position of semi-independence in the programme of this Association, it has, in the aggregate, received much attention at the meetings inaugurated with that at York in 1831. It is interesting to turn up the early volumes of the Reports, and to ascertain what was running in the minds of our predecessors, and what the problems that they thought it vital to solve. In the account of the first meeting in this town in 1833 we find a Report by Lindley on the Philosophy of Botany, two of the items in which are of interest to students of Rural Economy. Apparently at that time much attention was being given to the mode of the formation of wood. Two theories appear to have divided botanists—the one that wood was organised in the leaves, and sent down the stem in the form of embryonic but organised fibres, to be deposited on the surface of wood already formed. The other theory was that wood was secreted *in situ* by the bark and older wood. It is to the former of these theories that Lindley gives his adherence. Although this problem has ceased to interest, the same cannot be said of another subject discussed in the same Report, namely, the so-called "fæcal excretions" of plants. In the words of Lindley, "A new apple orchard cannot be made to succeed on the site of an old apple orchard unless some years intervene between the destruction of the one and the planting of the other; in

gardens no amount of manure will enable one kind of fruit-tree to flourish on a spot from which another tree of the same species has been recently removed, and all farmers practically evince, by the rotation of their crops, their experience of the existence of the law." He attributes to Macaire the demonstration of the fact that all plants part with a fæcal matter by their roots. These excretions he held to be poisonous, maintaining that, although plants generate poisonous secretions, they cannot absorb them by their roots without death, concluding that "the necessity of the rotation of crops is more dependent upon the soil being poisoned than upon its being exhausted." He indicated the lines along which investigation might with advantage proceed, one of the questions put forward being "the degree in which such excretions are poisonous to the plants that yield them, or to others."

In 1833 botanists and agriculturists had not the advantage of the knowledge that is at our disposal through the continuous growth for a long series of years of certain crops at Rothamsted, but consideration of the fact that some crops (as, for example, pure forests of beech, silver fir, Scots pine and other trees, as also permanent pasture) may be grown for hundreds of years on the same ground without any evidence of poisoning might have led to the conclusion that the law, as it was called, was not of general application. It is, of course, true that rotations are an advantage, and it is a matter of experience that certain crops—*e.g.* clover and turnips—cannot be grown continuously on the same land, but the cause is not now associated with excretions. The reason for the failure of clover, or the cause of land becoming "clover-sick," as it is called, is still a debated point; but I may hazard the conjecture that it is due to the fact that organisms or enzymes inimical to the vital activity of the minute living bodies, that exist in symbiotic relationship with the clover plants, increase with great rapidity when the living bodies that they affect are present in abundance. Red clover is the species that is usually associated with the term clover-sickness, but it would appear that a precisely similar phenomenon is exhibited in the growth even of wild white clover. It is a matter of common observation that on certain classes of land white clover is stimulated to such vigorous growth by the use of phosphatic manures that for one year at least it monopolises the area to the almost total exclusion of other plants. But such rank luxuriance is not of long duration. In a year or two the clover disappears to a very large extent, and cannot at once be restored by any process with which we are acquainted. The land has, in fact, become sick to white clover. But given a period of rest, during which the inimical agents will disappear, and it again becomes possible to stimulate white clover to vigorous growth. We have, it seems to me, an analogous state of things in the case of certain insects. On the Continent the caterpillar of the Nun Moth (*Liparis monacha*, L.) periodically proves extremely destructive to certain conifers, and it is found that in the first year the insects are moderately abundant, in the second they are excessively abundant, while in the third the visitation begins to decline, and usually terminates quite suddenly. The causes of this cessation have been thoroughly worked out, and are found in the great increase of parasitic insects, and insecticidal fungi, including bacteria. I believe it will be found that the almost sudden cessation of our periodic visitations of the diamond-back moth is due to a similar cause.

The failure of turnips is apparently largely, if not entirely, due to the increase of insects and parasitic fungi.

The subject of harmful excretions has recently obtained renewed attention through the work being done at the Woburn Fruit Station. No point has received more striking demonstration there than the harmful influence that growing grass exerts on fruit-trees. It has been shown that this prejudicial influence is not due to the withdrawal of moisture, to the curtailment of supplies of plant food, to interference with aëration, or to modifications of temperature. In Mr. Pickering's opinion,[1] "the exclusion of all these possible explanations drives us to believe that the cause of the action of grass is due to some directly poisonous action which it exerts on the trees, possibly through the intervention of bacteria, or possibly taking place more directly." It is satisfactory to know that the subject, which is of considerable scientific and practical importance, is likely to be vigorously followed up.

[1] The Effects of Grass on Apple Trees." *ournal R.A.S.E.* Vol. lxiv. p. 365.

In the early 'forties attention was being directed to a subject that even now has a great attraction for agriculturists, namely, the stimulating and exhausting effect of artificial manures, especially nitrate of soda. The principle that "stimuli lose their full effect upon living matter when frequently repeated" was generally held to account for the want of response that crops exhibited to repeated dressings of nitrate of soda; but Prof. Daubeny in 1841[1] pointed out what is now generally accepted as the true cause, namely, the exhaustion of the soil of other substances. This, he said, can be counteracted by giving other manures, of which he instanced bone meal. His suggestions for future investigations have been largely followed, though, as we now know, they are of theoretical rather than practical importance. He proposed the alternatives:

(1) Analysis of the soil, discovery of the amount of available plant food, and the application of the substances found to be deficient up to the probable measure of the crop's requirements.

(2) Discovery, by analysis of the yield, or estimation by calculation, of the amount of plant food removed in the produce, and the application to the soil in the form of manure of what was withdrawn by the crop.

Daubeny suggested that manuring should be undertaken on a system of book-keeping—on the one side being entered all the items of plant food taken out by crops, and on the other all that is applied in the form of manures, the two sides of the account being made to balance. This theory of manuring is distinctly suggestive, and often fits in rather remarkably with actual practice, though the comparative agreement between theory and practice is due to causes that the author of the theory probably hardly contemplated. Take, for instance, the case of wheat. An average crop removes from an acre about 50 lbs. nitrogen, 30 lbs. potash, and 20 lbs. phosphoric acid. This loss would be restored by the use of some 3 cwt. nitrate of soda, 2 cwt. kainit, and $1\frac{1}{2}$ cwt. superphosphate; and on many soils wheat could, no doubt, be grown continuously for many years on such a mixture, aided by good tillage, without the yield suffering materially. But we now know that much of the plant food offered in manure never enters the crop at all, so that the balancing of the account is due almost as much to chance as to calculation. This becomes more apparent when we regard such a crop as meadow hay, which in actual practice is often grown for a long series of years on the same land. To balance the withdrawal of phosphoric acid by an average yield of this crop only about $\frac{3}{4}$ cwt. of superphosphate per acre is theoretically necessary, but on most soils an average yield would not be maintained by the use of so small a quantity.

During the 'fifties the volumes of the Association contain several important contributions from the two distinguished Englishmen to whom the world's agriculture owes so much, Lawes and Gilbert. Their first contribution was made in 1851, and dealt with Liebig's mineral theory, a subject with which their names will always be associated. They drew upon their rich store of experimental data to prove that the yield of wheat is much more influenced by ammonia than by minerals, and they gave it as their deliberate opinion that the analysis of the crop is no direct guide whatever as to the nature of the manure required to be provided in the ordinary course of agriculture. With the reservation "in the ordinary course of agriculture," the dictum cannot be questioned, though in the circumstances of the continuous growth of wheat, as has been pointed out, conclusions indicated by the analysis of a crop happen to accord, at least approximately, with manurial practice.

Field experiments or demonstrations, which have been such a prominent feature of the educational work of the past decade, appear to have been first introduced at the meeting of the Association in 1861 by Dr. Voelcker.

While agricultural subjects have claimed a considerable share of the time of the Association, forestry has not been altogether overlooked. As early as 1838 we find attention being directed to what has of recent years come to be a burning question—namely, the maintenance of our timber supplies. At that early date, when the industrial develop-

[1] "On Manures considered as Stimuli to Vegetation."

ment of the country was, comparatively speaking, in its infancy, the estimate of our timber requirements was, in the light of present experience, amusing in its modesty. Captain Cook estimated that "100,000 acres of waste taken from the Grampian Hills for the growth of larch would in two generations not only supply the ordinary wants of the country, but enable us to export timber."[1] Assuming a rotation of eighty years, this estimate postulates that the produce of some 1200 acres, of a value of about 120,000*l.*, was sufficient to make us independent of foreign supplies. Such is the estimate of 1838; now let us turn to the estimate of 1904. Dr. Schlich, in his volume on "Forestry in the United Kingdom,"[2] passes in review Britain's timber requirements, and, after making allowance for woods like mahogany, teak, &c., which cannot be grown here, he comes to the conclusion that "if all these items are added up we find that we now pay for imports in timber . . . the sum of 27,000,000*l.*, all of which could be produced in this country." Assuming as before that the value of an acre of mature forest is 100*l.*, it means that our imports are drawn from 270,000 acres, and to maintain our supplies merely at their present level a forest area of more than 20,000,000 acres, worked on an eighty years' rotation, is necessary.

Although it has been reserved for the Cambridge Meeting of 1904 to witness the delivery of an Address from the Chair of an Agricultural Subsection, this is by no means the first occasion on which an agricultural subject has furnished the theme for a Presidential Address. In 1880 the then Dr. Gilbert presided over Section B, and chose for his subject Agricultural Chemistry; in 1894 Prof. Bayley Balfour inaugurated the work of the Biological Section with an Address on Forestry; while in 1898 the President of the Association focussed the vision of all thinking men on the greatest agricultural problem of all—the World's Supply of Wheat.

German Investigations on the Action of Conservation Agents on Farmyard Manure.

Those who have followed the progress of Agricultural Science in Germany must have noticed how much attention has been given during the past ten years to investigating the changes that take place in farmyard manure during storage under varying conditions. The stimulus and funds for this work have for the most part been supplied by the German Agricultural Society, which in 1892 resolved to carry through an exhaustive inquiry. For this purpose it enlisted the cooperation of several of the most fully equipped stations in the Empire, and the reports that have appeared bear testimony to the industry and analytical ingenuity that have been brought to bear on this important subject.

The experiments were originally designed to extend over four years, the first, 1892–3, being devoted to preliminary, chiefly laboratory, experiments; the others, to work on a scale more in accordance with farm practice. But although the period originally contemplated is now long past, the problem is by no means solved, and the Society has recently been making a fresh grant for additional experiments of a similar character. In point of fact, the subject has been found to bristle with difficulties, and the results obtained with small quantities of manure, or in summer, have not always been confirmed with large quantities of manure, or in winter.

In 1897 I published an account[3] of the more important results obtained up to that time, confining myself chiefly to questions of temperature and the loss of organic matter, and the conclusion arrived at was that "none of the conservation agents usually employed appears to have any very important influence on the decomposition of farmyard manure."

Since then several important reports[4] have appeared, and I propose shortly to refer to their contents.

[1] Cook, "On the Genera Pinus and Abies."
[2] Bradbury, Agnew and Co., 1904.
[3] *Journal Board of Agriculture*, September, 1897.
[4] Hansen and Günther, "Versuche über Stallmist-Behandlung," *Arbeiten der Deut. Land. Gesell.* Heft 30, 1898. Pfeiffer, "Stallmist-Konservirung," *Ibid.* Heft 73, 1902. Immendorff, "Ueber Stallmist-Bewahrung," *Mitt. der Deut. Land. Gesell.* Heft 21, 1903. Schneidewind, "Fünfter Bericht uber die Versuchswirtschaft," *Lauchstädt, Land. Jahrb.* xxxiii. p. 190.

While the experiments have in almost all cases dealt with the fate of nitrogen, phosphoric acid, and potash, the chief interest centres round the nitrogen, for, given reasonably satisfactory conditions of storage, it is only this constituent of farmyard manure that is likely to suffer loss. But much importance, from the experimental point of view, attaches to the analytical results obtained with the other two substances, for the reason that the quantities of these found are the surest test of the accuracy of the work. The general method of procedure has been to employ a fairly simple but sufficiently nutritious food-mixture, and to allow a definite quantity of this and of litter for a certain number of selected cows. The weight of nitrogen, phosphoric acid, and potash in the food is accurately determined, all of which ultimately reaches the manure, less what goes into the milk, and into the live-weight increase, if any. If the account of what the animals receive as food and litter, and what they furnish as liquid and solid fæces, milk, and animal increase, approximately balances as regards mineral matter, it may be assumed that the sampling and analysis have been sufficiently accurate to justify definite conclusions being based on any deficiency in nitrogen that may be found.

The work of Hansen and Günther, Pfeiffer, and Immendorff was carried out at consecutive periods from 1893 to 1902, at the experimental station of Zwätzen, near Jena, where stalls and dung-pits had been constructed for the purposes of this research. Schneidewind's experiments were conducted at the station of Lauchstädt, near Halle.

Effects of Kainit.—This was used by Hansen and Günther at the rate of 0·75 kg. per 1000 kg. live weight of stock per day, while Pfeiffer and Immendorff used twice as much. The kainit was in no case spread on the litter in the stall, as this would have caused inflammation of the skin of the udder, legs, and abdomen of the cows, but was sprinkled on the manure as spread and pressed into the pits. In certain series of the experiments the manure was removed from the stalls daily, in others it was only removed once a week. Two weeks was the usual time necessary to collect a sufficient quantity of manure, which, with the liquids, usually amounted to about 8000 kg. at Zwätzen, and about one-fifth of this weight at Lauchstädt. The period of storage was generally about four months.

Hansen and Günther found that in pits the untreated manure lost 11·5 per cent. of nitrogen; while the manure treated with kainit lost 14·4 per cent.

Pfeiffer found that the loss of nitrogen in untreated manure was 17·2 per cent., which compares with a loss of 19·5 per cent. in the presence of kainit. The loss of nitrogen when kainit was used by Immendorff was 21·3 per cent., the loss in the untreated manure not being given in his tentative report so far available. Schneidewind did not experiment with kainit. The results of these experiments are in complete relative agreement, and show that the loss of nitrogen is greater when kainit is used than when it is withheld.

Effects of Superphosphate.—This substance was spread twice daily over the litter in the stall at the rate of 0·75 kg. per 1000 kg. live weight. The results obtained were as follows:—

—	Loss of Total Nitrogen	
	In untreated dung	When super. used
Hansen and Günther ...	10·25	16·25
Pfeiffer	17·20	20·80
Immendorff	—	19·80

With superphosphate, as with kainit, the loss of nitrogen during the storage of dung has been increased. It may, however, be mentioned that Hansen and Günther and Immendorff found that superphosphate conserved nitrogen to an appreciable extent so long as the dung lay in the stall, but that its effects disappeared whenever its acid phosphate and free sulphuric acid had been neutralised by ammonia, and this rapidly occurred in the pit.

Effects of Precipitated Phosphatic Gypsum.—This at the

rate of 1 kg. per 1000 kg. live weight was tried by Hansen and Günther and Immendorff, the substance employed containing fully 8 per cent. P_2O_5. It was spread twice daily on the litter in the stall. The result obtained by Hansen and Günther was that after lying for seventeen weeks in the pits the manure that had been untreated had lost 10·35 per cent. of nitrogen, whereas that treated with the phosphatic gypsum showed a loss of 14·47 per cent. The loss of nitrogen found by Immendorff when this substance was used amounted to 19·8 per cent. This substance, like the others, would therefore appear to be valueless as a fixer of nitrogen.

Effects of Gypsum.—This substance has long been recommended as an agent for conserving nitrogen in the dung-heap. The results of its use, spread twice daily on the litter in the stall at the rate of 1 kg. per 1000 kg., live weight, in the experiments conducted by Hansen and Günther, were that in the presence of gypsum the loss of nitrogen amounted to 11·89 per cent., which compares with a loss of 8·56 per cent. when nothing was mixed with the dung.

Schneidewind, using a much larger quantity of gypsum, namely, 5 lbs. per 100 lbs. of dung, found that the loss of nitrogen was reduced from 35·69 per cent. to 15·22 per cent. In this connection he says: "The use of gypsum has markedly reduced the loss of nitrogen. Assuming the conserved nitrogen to have a good action on the crop, this agent may be said to have paid. But as the bulk of the nitrogen so conserved was found to consist of slow-acting albuminoid compounds, and seeing that the sulphate of lime was largely reduced to sulphides, which are directly injurious to plants, we cannot conclude that the use of gypsum has been profitable. Investigations with this substance will, however, be continued."

Hansen and Günther carried their experiments the length of using the various lots of manure on crops, but this part of their researches was hardly more favourable to the use of conservation agents than the other. They thus express themselves: "When the various manures were used on crops, five times in six the treated manure acted no better than the untreated. Only on one occasion was an improvement observable. Field and pit experiments alike have proved that the conservation agents employed are of no value." Schneidewind expresses himself equally forcibly when he says: "As the result of many experiments conducted by ourselves and others, we have arrived at the conclusion that chemical substances are valueless as conserving agents."

Pfeiffer also tried sulphuric acid sprinkled over the manure as it was placed daily in the pit, when it was found that the loss of nitrogen was reduced from 27·8 per cent. to 7·1 per cent. In this connection Pfeiffer says: "The cost, however, was nearly a mark for each kilo. of nitrogen conserved, and the use of sulphuric acid is associated with so many drawbacks that its employment cannot be recommended."

Schneidewind came to a similar conclusion, and thus expresses himself: "As a result of numerous conservation experiments carried out with various quantities of sulphuric acid, and with various acid sulphates, we cannot advise the use of these substances."

But although no benefits have been obtained from the use of the substances indicated, some useful information is available as to the advantages of giving attention in other directions to the management of farmyard manure. Hansen and Günther took four lots of manure of similar character, storing two of the lots in pits and placing the other two in heaps in the open field. From the end of September until the middle of December the pitted material had on the average parted with 13·25 per cent. of total nitrogen, whereas the loss in the manure in heaps averaged 25·3 per cent. When the behaviour of the ammoniacal nitrogen was investigated it was found that the loss was 35·73 per cent. in the pits and 82·5 per cent. in the heaps. The loss, therefore, is greatest in that part of the nitrogen which is the most active and the most valuable.

In another series of experiments by the same investigators the manure was all placed in pits, but in one case it was spread equally and trodden down, while the escape of liquids was prevented. In the other case the manure was simply thrown loosely and irregularly into the pit without spreading or treading, the surface being left uneven and therefore much exposed to the air, while the liquids were allowed to drain away. After lying for twenty-two weeks the loss of nitrogen was 15·76 per cent. in the pit containing the carefully treated manure, whereas in the other pit the loss amounted to 34·58 per cent.

Pfeiffer in a series of experiments proved that much of the nitrogen that disappears from manure is lost before the manure is transferred from the stall to the dungstead. He is strongly of opinion that stalls, boxes, and the like, should either be cleaned out twice daily, or, if the construction admits, the manure should be left to accumulate until it is some feet in depth, as in the system of management that prevails in cattle-courts and yards in this country.

The general conclusion arrived at, and clearly expressed by Pfeiffer, is that excessive loss in manure can be best avoided by storing it in a deep mass in a water-tight dungstead placed in a well-shaded situation, in which the material is firmly compressed. The necessary compression can be secured in various ways, perhaps most conveniently and effectively by means of the treading of cattle. The use of a considerable proportion of moss-litter is strongly recommended. This substance not only absorbs and retains the liquids, but, being acid, it fixes ammonia. In the absence of moss-litter, loamy soil rich in humus will prove a useful substitute.

The Chemical Fixation of Atmospheric Nitrogen.

It has for long been the dream of chemists to discover, or welcome the discovery of, a chemical process, capable of industrial application, by which the nitrogen of the air could be made available to replace or to supplement our rather limited supplies of nitrogenous manures. In his Presidential Address, Sir William Crookes had something to say on this fascinating subject, and looked hopefully to electricity to solve the problem. He pointed out that with current costing one-third of a penny per Board of Trade unit a ton of nitrate of soda could be produced for 26*l.*; while at a cost of one-seventeenth of a penny per unit—a rate possible when large natural sources of power, like Niagara, are available—the cost of such artificial nitrate of soda need not be more than 5*l.* per ton.[1]

Dr. von Lepel, in giving an account of recent work on this subject to the winter meeting of the German Agricultural Society in February of this year,[2] puts the cost of electric nitrate, as compared with Chili nitrate, in the proportion of 24 to 39, which is in close agreement with Sir William Crookes's estimate. Lepel points out that the material obtained, neutralised by some alkali, consists of a mixture of nitrate and nitrite. When used in pot-culture experiments it has given results closely agreeing with those furnished by Chili nitrate.

Good progress would also appear to have been made in another direction in the commercial fixation of atmospheric nitrogen, and a short account of the results was communicated by Prof. Gerlach, of Posen, to the meeting of the German Agricultural Society already referred to, and is published in the same issue of the *Mittheilungen.*

When air which has been freed of oxygen is conducted through finely disintegrated calcium carbide at a high temperature, one atom of carbon is displaced by two atoms of nitrogen, and calcium cyanamide ($CaCN_2$) is formed. This substance is also produced when a mixture of lime or chalk and charcoal is heated to a temperature of 2000° C. in a current of air.[3] When pure, this substance holds 35 per cent. of nitrogen, but in its crude commercial form it contains only about 20 per cent. Treated with acids, calcium cyanamide is changed into dicyandiamide, a substance holding nearly 67 per cent. of nitrogen, but directly poisonous to plants. Or, if heated in superheated steam, calcium cyanamide parts with all its nitrogen as ammonia, which, of course, is easily brought into a portable form.

But experiments conducted at Posen and Darmstadt during the past three years, both in pots and in the open field, have shown that calcium cyanamide itself is a useful nitrogenous manure, field experiments giving results about 20 per cent. below those obtained by the use of an equal amount of nitrogen in the form of sulphate of ammonia.

[1] Crookes, "The Wheat Problem," p. 47.

[2] Dr. von Lepel, "Neuere Versuche zur Nutzbarmachung des atmosphärischen Stickstoffs durch Elektrische Flammenbogen," *Mitteil. d. Deut. Land. Gesell.*, 1904, Stuck 8.

[3] Bull, *Imp. Inst.* June 30, 1904.

In prepared soil in pots the results fully surpassed those obtained both with nitrate of soda and sulphate of ammonia, the less satisfactory yields obtained in the field being perhaps due to the organic acids inducing the formation of a certain amount of the poisonous dicyandiamide.

So far as one may judge from the information available, it would appear that agriculture will not have long to wait until it is placed in the possession of new supplies of that most powerful agent of production, nitrogen, and Sir William Crookes will see the fulfilment of his prediction that "the future can take care of itself."

Nitragin.

A few years ago much interest was excited in this and other countries by the announcement that the scientific discoveries of Hellriegel and Wilfarth had received commercial application, and that the organisms of the nodules of the roots of Leguminosæ could be purchased in a form convenient for artificial inoculation. The specific cultures placed upon the market were largely tested practically and experimentally, but the results were such as to convince even the patentees, Nobbe and Hiltner, that the problem which promised so much for agriculture had not been satisfactorily solved. Since that time, however, investigators have not been idle, and the present position of the subject is to be found in a recent Report by Hiltner and Störmer.[1]

It was early recognised that the organisms (bacteria) which inhabited the root-nodules of the various species of Leguminosæ were not all alike, and that, in fact, they showed marked physiological if not morphological distinctions. Any particular species of leguminous plant is found to resist more or less successfully the attempt of these various organisms to effect an entrance into its root-hairs, and according to the power of the organism to gain access, and to establish colonies, so is the particular plant benefited and the stock of fixed nitrogen increased. This power of adaptability of the organism is designated its "virulence," a term, however, which is perhaps hardly suited to our English mode of expression, though it may for the present be retained. It has been found that organisms of what is called "high virulence" are capable of entering with ease the root-hairs of vigorous plants at an early stage of their growth, and of inducing the formation of nodules that are large, numerous, and placed high up on the roots. Organisms of low virulence, on the other hand, can only enter plants of feebler growth, or plants that have passed the most vigorous stage of youth, so that the nodules, in this case, are small and scarce, and distributed, for the most part, near the ends of the roots. The practical object, therefore, would appear to be the breeding of strains or varieties of organisms of high virulence, adapted to the symbiotic requirements of the various important species of farm and garden leguminous crops.

The nitragin put on the market a few years ago was used in two ways, being either applied directly to the fields, or mixed with water and brought into contact with the seed before sowing. Under the former method of procedure an increase of crop was obtained only when the nitragin was used on land containing much humus. The explanation given for failure under other conditions was that the bacteria artificially introduced perished for want of food before the leguminous seed germinated and produced plants.

Failure of the nitragin to effect an improvement in the crop when it was sprinkled on the seed is now believed to be due to the action of secretions produced by the seed in the early stages of germination. These secretions are found to be rich in salts of potash, and when brought into contact with the bacteria in question they induce changes allied to plasmolysis, and these changes are subsequently followed by death. This difficulty was found to be got over by moistening the seed and allowing it to sprout before the nitragin was applied; but manifestly such a procedure would always be difficult, and often impossible, to carry out in practice. The object, however, would appear to have been gained in another way, namely, by cultivating the bacteria in a medium that imparts to them the necessary power of resistance. Such nourishment may take various forms, but that which gave the best results consisted of a mixture of skim milk, grape sugar and pepton, and it is in this medium that the organisms of the nitragin now distributed are cultivated.

[1] "Bericht über neue Untersuchungen über die Wurzelknöllchen der Leguminosen und deren Erreger," *Arbeiten aus der Biol. Abteil. für Land- und Forstwirtschaft am K. Gesundheitsamte*, Band iii. Heft 3.

Early in the present year the new nitragin was being offered free of cost to all members of the German Agricultural Society on the condition that it was used in accordance with the directions that accompany it. In consequence of the large demand the free offer was in April withdrawn, but the substance may be purchased from Prof. Hiltner, of Munich, in quantities sufficient to treat the seed of a half to one acre at the price of one shilling. The United States Department of Agriculture are so convinced of the practical utility of the improved nitragin that they are distributing large quantities to American farmers. In this way the material will be thoroughly tried in two hemispheres under practical conditions, and abundant evidence should soon be forthcoming as regards its effects. It is to be hoped that British investigators will not be deterred by past disappointments from putting the new form of nitragin to the test.

Improvement of Varieties of Crops.

Speaking generally, the attention of agricultural investigators during the past fifty years has been directed more to manurial and similar problems than to the improvement of the yield of crops through the agency of superior varieties. This, it seems to me, is the outcome of the tradition that agricultural science is based upon chemistry, using the term in its old-fashioned and restricted sense, and as a consequence farmers have looked principally to the chemical laboratory for light and leading. It is true that much excellent work has been accomplished from the botanical side, but this has been performed rather by farmers, seedsmen, or amateurs, than by trained botanists. But fortunately the botanist is now getting his opportunity, and the possibilities before him are sufficiently attractive.

Judging by the results that have been obtained, it would appear that wide divergences as regards yield, nutritive qualities, resistance to disease, and other important properties exist between varieties of the same plant-species; so much so, in fact, is this the case that attention to the relationship between variety and locality would appear to be one of the most important matters to which a farmer can give consideration. But it has been found that new varieties are frequently unstable, reverting rather rapidly to an unsatisfactory form, or displaying a lack of power of resistance to disease. It therefore becomes necessary constantly to be producing new varieties to take the place of those that are worn out, and it seems reasonable to anticipate that the professional botanist will take a much larger part in this work than has been the case in the past.

Not only is the yield of a crop greatly influenced as regards quantity and quality by the variety of seed employed, but, as is well known to practical farmers, the local origin of the same variety of seed has a marked influence on many properties of plants (vigour, resistance to disease, and resistance to frost, and to weather generally), and these properties quickly react on the yield. In this country we have a prejudice in favour of the seed of English-grown red clover, Provence Lucerne, Scotch potatoes, Belgian flax, Ayrshire ryegrass, pine and larch from Scotland, Norfolk and Cambridge barley, Warp-land wheat, &c., and there seems no reason to doubt that such preferences are based upon sound experience. This subject would appear to be one that is still full of interesting and important possibilities, and last year I had the opportunity of seeing some striking results in a new and unexpected direction. During the past few years the Austrian Experimental Forestry Station of Mariabrunn has given much attention to the influence of the local origin of the seed on the resulting trees, especially the common spruce, and, although it is too early to pronounce a final judgment on the results, these are already so conspicuous as to warrant my placing some figures before you.[1]

In the autumn of 1896 a supply of seed was obtained from certain definite localities, the trees that yielded it being of varying dimensions and situated at various altitudes. The seed was sown in the spring of 1897 in the nursery attached to the station, and, having been transplanted into lines, a portion of the young trees are growing there now. Others

[1] "Programm der vierte Versammlung des Internat. Verbandes Forstlicher Versuchsanstalten zu Mariabrunn," 1903, p. 47.

were, in 1899, planted out in a wood (Loimannshagen) in the neighbourhood. In the autumn of 1902 the young trees were carefully measured, with the following results:—

Locality of Origin of the Seed	Height above Sea-level of the Mother-tree	Average Annual Height-growth of the Mother-tree	Average Height (1902) of the Young Trees		Average Growth in Height of the Nursery Trees in 1902
			In the Wood	In the Nursery	
	metres	cm.	cm.	cm.	cm.
Piesendorf, Salzburg ...	1400	24	62	85·2	34·7
,, ,, ...	1750	14	47	61·6	23·3
St Andra in Karnten ...	1420	25	57	71·1	27·1
,, ,, ...	1625	18	41	51·2	18·4
,, ,, ...	1650	15	35	39·1	14·2
Treibach, Karnten ...	900	28	56	81·6	30·7
,, ,, ...	900	29	53	80·9	29·7
Achenthal in N. Tyrol...	900	31	64	87·9	29·0
,, ,, ...	1300	28	67	80·5	27·9
,, ,, ...	1600	26	50	62·2	21·8

These figures show—

(1) That where, in any particular locality, mature trees were measured at different elevations, the tallest trees, as was to be expected, were found at the lowest elevation.

(2) That where the seed of such trees was sown the height of the resulting trees, at the age of six years, was in close relationship to that of the mother trees.

(3) That where mother trees of approximately equal height from the same locality and the same elevation (Treibach) were selected, the resulting progeny were also of approximately equal vigour.

The differences in the height-growth of the young trees are so striking as to lead to the conclusion that the financial returns of Forestry operations may be profoundly modified by the origin of the seed, and it would apparently pay nurserymen and planters well to give their careful attention to this subject.

Joint or Cooperative Work.

In conclusion, I may be allowed to direct your attention to a prominent feature of experimental or demonstrational work which is found to exhibit itself in all countries of the world where serious attention is given to the improvement of agricultural production. While, no doubt, it is the individual who plants the germ of a new idea and fosters its growth until it is fairly established, it is by systematised cooperative effort that the practical value of the idea is tested, and that the knowledge is made available and acceptable to the workaday farmer. Various objections have been urged against field experiments, and it need not be denied that they are incapable of supplying a satisfactory answer to many scientific questions. Such experiments are exposed in no small degree to the disturbing influences of inequalities of soil, irregular cultivation, the attack of animals, and the vicissitudes of climate; but when reasonable precautions are taken to guard against these, and given a sufficient number of tests, the results of field trials are of the highest value as a guide to practice. Apart from attention to the preliminary details of the scheme, and to care in carrying it out, the main point to aim at in field-trials is to have them so frequently duplicated or repeated that the disturbing factors inseparable from field-work will be largely eliminated. Such duplication may take the form of repetition of the same test on the same area year after year, when one obtains some such series of results as those that have helped to make the reputation of Rothamsted. But however convincing may be the results of a series of experiments that have marched majestically on for half a century, they lack attractiveness for the investigator who desires to solve not one but many problems during his lifetime. For him, therefore, duplication in time gives place to duplication in space—in other words, he secures the same end, or an end that is in many respects equivalent, by repeating the test at several places in the same season, or in a short series of seasons. This method of work is, of course, by no means new. It was utilised with great advantage by the late Dr. Voelcker, and by our more recently departed friend Dr. Aitken, and it is a line that is still being followed by the two great societies with which these distinguished workers were so long associated. The method is also being practised extensively, chiefly through the agency of societies, in Germany, France, and other European countries, and it has taken firm hold in the United States and in some of our colonies. One of the largest and most successful agencies in cooperative demonstrations is to be found in Canada, where, during the past nine years, an average of 37,000 farmers have annually received small parcels of improved seeds through the Government experimental organisation directed by Dr. Saunders. It is claimed that the financial results to the country as a whole run to many millions of dollars, and there seems to be no reasonable doubt as to the accuracy of the statement.

I trust you will pardon my referring in this connection to a matter that is personal to a considerable proportion of this audience, and of saying that, in my opinion, one of the best pieces of work that has been done in this country in recent years is the preparation of the scheme of joint experiments by the Agricultural Education Association. The problems set for solution under that scheme are of the simple, direct, practical kind that field-work is thoroughly qualified to deal with. But the essence of success lies in the power of numbers, and the control of this factor rests with the members of the Association themselves. Now, most of the members of that Association are not only investigators but also teachers, and many of the institutions that they represent have recognised the advantages of keeping in touch with their past pupils through the agency of collegiate Associations. These old students, it seems to me, represent a large mass of most valuable material for carrying through cooperative experimental work of the class referred to, and I am convinced that the agriculture of the country would benefit in no small degree were this powerful agency fully utilised.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY THE RIGHT REV. THE LORD BISHOP OF HEREFORD, D.D., LL.D., PRESIDENT OF THE SECTION.

I AM moved to begin this address with a word of personal apology, the strongest feeling in my mind, as I rise to deliver it, being that in the fitness of things some one of the many distinguished representatives of education in this University would have been the natural occupant of this chair on the present occasion; and for my own part I could hardly have brought myself to accept the invitation with which I have been honoured had I not been led to understand that on occasions of this kind it is preferred by the members of the University visited that some one from the outside should be invited as I have been.

Thus I have accepted, not without hesitation and misgiving, but with the more gratitude, as feeling that I am here because of the wish of the Cambridge authorities to have someone connected with the University of Oxford, and I desire that the grateful acknowledgment of this courtesy and kindness should be my first word as President of the Educational Section.

The inclusion of Education among the various sections of this Association for the Advancement of Science is sufficient evidence that a new educational era has begun in this country.

Whatever may be the defects of our educational system or want of system, whatever changes may be necessary to bring it, in the current phrase, up to date, the days of unthinking tradition are over.

Scientific method is entering on its inheritance, and it has begun to include the field of education along with other fields of life and thought within the sphere of its influence.

And scientific minds are asking on every side of us what is the end of true education, and are we on the right way to it?

True education, almost insuperably difficult in practice, has been often defined in words.

Plato told us long ago how it is music for the soul and gymnastic for the body, both intended for the benefit of the soul, how it is a life-long process, how good manners are a branch of it and poetry its principal part, though the

poets are but poor educators, how great is the importance of good surroundings, how the young should be reared in wholesome pastures and be late learners of evil, if they must learn it at all, how nothing mean or vile should meet the eye or strike the ear of the young, how in infancy education should be through pleasurable interest, how dangerous it is when ill directed, how it is not so much a process of acquisition as the use of powers already existing in us, not the filling of a vessel, but turning the eye of the soul towards the light, how it aims at ideals and is intended to promote virtue, and is the first and fairest of all things.

In this description, I take it, we most of us agree, though some of Plato's views would doubtless elicit differences of opinion amongst us, as, for instance, that education ought not to be compulsory, or that it should be the same for women as for men.

One of his statements may be soothing to our English self-complacency, for as is the habit of idealists in every age, he says that even in Athens they care nothing for educational training, one of the most brilliant of their younger statesmen pleading that it does not matter, because others are as ignorant as he.

Or again, our own Milton sums it up in fewer words, but very impressively, when he says true education fits a man to perform justly, skilfully, and magnanimously all the offices, both private and public, of peace and war.

It is a noble aim which he thus sets before us, to make our sons skilful, just, magnanimous, and every description of aims and methods can be little more than an expansion of it.

Of the importance of right aims and ideals there can, as Plato reminded us, be no question, because of the danger of ill-directed aims, and the lasting nature of early impressions.

What we learnt at school, when all the world was young to us, whether we learnt it with weariness or pain, or under happier influences with a quickening pulse and the glow of enjoyment, passed into the blood, as Stevenson said somewhere, and became native in the memory.

True education, then, as we all acknowledge, aims at cultivating the highest and most efficient type of personality, men not only appropriately and technically equipped for their professional business, but men endowed with the best gifts and inspired with high purposes, men who desire to follow the more excellent ways and to lead others in them, who love knowledge, truth, freedom, justice, in all the relations of life, whether individual or social, men marked by sense of duty and moral thoughtfulness, public spirit, and strength of character.

Such an education is the true basis of individual and national welfare, and experience has abundantly shown how necessary this is to save men from distorted views of history, from wrong conceptions of patriotism and public duty, from mistaken aims and disastrous policy.

Thus, for instance, a good and true education shows us that the true basis of life is moral and economic and not military, and the true aim of both individuals and nations is knowledge, justice, freedom, peace, magnanimity, and not pride, aggression, force, or greed.

Scientific consideration of our subject will of course deal largely with such details as the relative claims of the humanist and the realist, subjects and methods of instruction, the correlation of different grades of education, the adaptation of this or that system to special needs, and so forth; but through all this these fundamental requirements of the true education, as placarded before us by Plato or by Milton, must always hold the chief place, and all others must be kept in due and conscious subordination to these.

This very obvious remark calls for repetition, as we are so apt to lose sight of ideals amidst the dust of controversy about details or methods or practical needs.

How, then, does our English education stand when thus considered? And what signs are there in our life of our having fallen short or fallen behind, or missed the best that was possible in our circumstances?

It may, I venture to think, be fairly said that to a reflective observer various things are patent which seem to make it expedient that the subject of education should have its place in the proceedings of a scientific association like this, although there may be difference of opinion as to how it should be handled there.

In saying this I have to admit that some educational reformers seem to have doubts as to the propriety of its inclusion in your programme.

The element of personality is so preeminently vital in all education that some men say it cannot be treated as wholly scientific in the ordinary sense, and that there is serious risk in subjecting it too rigidly to the methods of investigation which naturally hold the field in the main departments of this Association, and that men who are wholly accustomed to such methods are not the best equipped for dealing with the problems involved in the education of the young.

If I endeavour in a few paragraphs to express what, so far as I understand it, is the ground of this fear in the minds of some thoughtful objectors, I trust I may not be thought to be wasting your time.

This Section is still in its swaddling-clothes. It has to justify its existence in the coming years. It is therefore of moment that it should be started on its course of early growth as free as may be from prejudice and with the sympathy and support of all who, whatever be their views as humanists or realists, as men of letters or men of science, as teachers of religion or men of practical affairs, desire to see the education of the young in our country advancing and expanding on the best lines.

On this account the misgivings or warnings of every thoughtful critic deserve our attention and may be helpful.

In what I am saying it will be understood, I hope, that I am not expressing views of my own, but endeavouring to act as the recording instrument, a very inadequate and old-fashioned instrument, of views which come to me from one quarter and another.

The inclusion of the study of education by the British Association for the Advancement of Science among its subjects of investigation is, they say, not altogether free from risk.

If you treat education too exclusively according to the analytic naturalistic methods of scientific men you incur the danger of unfitting teachers for the best part of their work, which depends on the inspiring influence of personal ideals breathing through all their lessons, on a vivid sense of the subtle element of personality in the pupil, and on their responsible exercise of the power of their own personality.

In giving the scientifically educated teacher the analytic knowledge of the dissecting chamber you may possibly rob him of the magnetic power of personal sympathy and influence. In this sense, at all events, you must not dehumanise him. The most eminent psychologists, the critics tell us, are beginning to recognise the danger, and they bid the educator beware of science which has a great deal to say about mental processes but takes too little account of the emotions and the will, and seems inclined to forget that men are personalities and not plants or trees or machines and that boys will be boys.

The combination of a living and fruitful experience, these critics assert, with systematic organised scientific methods and processes is more difficult in education than in any other realm of knowledge, because the data are so complicated and so subtle and elusive.

Hence, they say to me quite frankly, the risk of failure to do much that will be of real value in your Educational Section.

In particular I have the impression that they set no great store by presidential addresses, although the address to which you are now listening has at least one merit, that it has no claim to be technically scientific, but is wholly based, so far as any positive conclusions or recommendations are concerned, on practical personal observation and experience.

This section, say the critics, will do its best work by seeking first of all to determine and to set forth :—

(1) What field is to be covered when education is to be treated as a scientific study, and what are the limits of the field, taking care to give due regard to right ideals of moral and social progress as a primary part of the whole.

(2) What methods of investigation are appropriate and what are inappropriate to the study of education.

Such are some of the warnings with which we are asked to begin our discussions. The critics ask the men of science to remember that they are leaving their accustomed field of purely natural phenomena, and entering a field of investi-

gation which is largely, if not mainly, social, political, religious, moral, and lends itself only in a limited degree to those problems which men whose sphere is natural science are more accustomed to handle.

These are some of the criticisms which, as men of science, you have to meet, and I may safely leave them to your tender mercies.

For myself my attitude in the whole matter must of necessity be a humble one. For many years of my life I was a teacher, but entirely untrained, or rather self-taught, that is to say, relying for my instruction and guidance entirely on my own reading, observation, experience, and practice.

I belong to the pre-scientific age of Englishmen engaged in education. I grew up to my profession anyhow, like so many others; and now for some years I have ceased even to teach, and so even as an untrained teacher I am out of date.

It is due to this audience and to my subject that I should say thus much. It is my appeal for your kind indulgence.

As regards the critics whose views I have endeavoured to express, I may say at once that I do not go with them, because I am profoundly convinced that our English education needs the influence of more light and more thought from every quarter, and especially from those who are familiar with scientific methods. "Blessed are they that sow beside all waters."

Moreover, I hail the application of scientific intelligence and scientific methods to this subject, because, looking back, I am profoundly conscious that I should have done my own educational work far less imperfectly if in my youth I had undergone any rational scientific illuminating preparation for it.

In such a process I should have lost no personal gift or aptitude that I possessed, and I should have gained some early knowledge and confidence and power which would have saved me much discomfort and anxiety and some mistakes and failures, and would have saved my pupils some loss and possibly some distress.

When I turn with these thoughts in my mind and look out over the field of English life I see very strong and valid reasons why our education, its merits, its defects, its methods and results, should be seriously considered here, as also in very different assemblies elsewhere.

Above all, the persistently traditional and unscientific spirit that still pervades so much of it from top to bottom, its lack of reasoned reflection, demands our special attention.

"The want of the idea of science, that is of systematic knowledge," said Matthew Arnold, "is, as I have said again and again, the capital want at this moment of English education and English life. Our civil organisation (including our education) still remains what time and chance have made it."

This was written about thirty-six years ago, and it is, to say the least, a surprising thing that in an age of unusually rapid scientific development it should be, in the main, still so true, as it undoubtedly is, of a great part of our English educational system.

There is the lack of any systematic preparation for the business of teaching which still prevails throughout our middle and upper-class education, although here in Cambridge and in Oxford some excellent pioneer work is being done in the training of teachers.

There is the general lack of interest in education which is still so noticeable in a great deal of English society of all grades, the spirit of indifference to it, and even the tendency to depreciate the intellectual life.

There is the excessive influence of tradition and routine on our great schools and universities, and in some quarters an inert or suspicious conservatism.

There is throughout our middle-class education a state bordering on chaos, a country largely unexplored, a mixture of things good and bad, involving a vast amount of wasted opportunity and undeveloped faculty.

Even in elementary education, which has received the largest share of public attention, there is much that needs to be done in a more thoughtful and scientific spirit.

Party politics have to be eliminated as far as possible, especially ecclesiastical politics.

The fitness of a great deal of the teaching to the special needs and requirements of the children has to be considered afresh.

The tendency to overlook the interests and the attainments of each individual child has to be checked.

The wastefulness of our absurdly truncated system of elementary education stopping abruptly at about twelve years of age and then leaving the children to drift away into an unexplored educational wilderness has to be superseded by some rational system of continuation classes made obligatory. Truly the harvest is a plenteous one for those who desire to uplift our English life by helping forward the best modes of educating the rising generation in a scientific, or, in other words, a wise, intelligent, and large-minded spirit.

Much, it is true, has been done in almost every part of the educational field during the last half-century, but not nearly so much as ardent friends of education anticipated forty years ago.

I have already quoted some significant words from Mr. Arnold's illuminating Report on the Schools and Universities of the Continent as he saw them thirty-seven years ago. If that report had been turned to immediate practical account at the time, if some English statesman, like William von Humboldt, had been enabled with a free hand to take up and give effect to Mr. Arnold's chief suggestions, as Humboldt and his colleagues gave effect to their ideas in Prussia in the years 1808 onwards, the advantage to our country to-day would have been incalculable.

In our insular disregard or depreciation of intellectual and scientific forces actually working in other countries, we have undoubtedly wasted some of that time and tide in human affairs which do not wait for either men or nations.

But, putting regrets aside and turning to some of the practical problems that seem to confront us to-day, I venture to put before you for consideration such cursory and unsystematic observations or suggestions as my personal experience has led me to believe to be of practical importance. For more than this I have no qualification.

In the first place, the growth of crowded city populations and the conditions under which multitudes have for at least two generations been growing up and passing their lives in our great cities have set us face to face with the very serious preliminary problem of physical health.

If our physical manhood decays all else is endangered, so that the first business of the educator is to look well to the conditions of a healthy life from infancy upwards.

Hence the great educational importance of the petition presented by 14,718 medical practitioners, including the heads of the profession, to the central educational authorities of the United Kingdom.

This petition opens with these impressive words:—

"Having constantly before us the serious physical and moral conditions of degeneracy and disease resulting from the neglect and infraction of the elementary laws of hygiene, we venture to urge the Central Educational Authorities of the United Kingdom (the Board of Education of England and Wales, the Scotch Education Department, the Commissioners of National Education in Ireland and the Intermediate Education Board of Ireland) to consider whether it would not be possible to include in the curricula of the Public Elementary Schools, and to encourage in the Secondary Schools, such teaching as may, without developing any tendency to dwell on what is unwholesome, lead all the children to appreciate at their true value heathful bodily conditions as regards cleanliness, pure air, food, drink, &c. In making this request we are well aware that at the present time pupils may receive teaching on the laws of health, by means of subjects almost invariably placed upon the Optional Code. By this method effective instruction is given to a small proportion of the pupils only. This does not appear to us to be adequate. We believe that it should be *compulsory* and be given at a much earlier age than at present."

And it concludes as follows:—

"In many English-speaking countries, definite attempts are being made to train the rising generation to appreciate from childhood the nature of those influences which injure physical and mental health. Having regard to the fact that much of the degeneracy, disease, and accident with which medical men are called upon to deal is directly or indirectly due to the use of alcohol, and that a widespread ignorance

prevails concerning not only the nature and properties of this substance but also its effects on the body and the mind, we would urge the Board of Education of England and Wales, the Scotch Education Department and the Irish Education Authorities to include in the simple hygienic teaching which we desire, elementary instruction at an early age on the nature and effects of alcohol. We gladly recognise (1) the value of the teaching on this subject given in some schools in Ireland and in a proportion of the schools of Great Britain, by means of reading primers, moral-instruction talks, &c., and (2) the excellence of the occasional temperance lessons provided in certain schools by voluntary organisations: but until the four Central Educational Authorities of the United Kingdom include this subject as part of the system of National Education, it appears to us that the mass of the pupils must fail as at present to receive that systematic teaching of hygiene and of the nature and effects of alcohol, which alone we consider adequate to meet the national need. Finally, we would venture to urge the necessity of ensuring that the training of all teachers shall include adequate instruction in these subjects."

This petition, coming, as it does, with all the weight of the medical profession, as the expression of their experience and convictions, is, to my mind, one of the most important educational documents which have been published in our time, and it can hardly be disregarded without incurring the charge of folly.

It may be worth while to set it for a moment side by side with the fashionable cult of athleticism, as bringing into relief our curiously unscientific inconsistency in such matters.

On the one hand, in our absent-minded way, we have allowed these generations of town-dwellers, to say nothing of rural villagers, to grow up and live under insanitary conditions which inevitably produce a physically degenerate, enfeebled, and neurotic race of men and women.

On the other hand, in the upper and middle classes, we have been sedulously cultivating the taste for physical exercises, outdoor life, athletics, and sport, thinking nothing of such importance as the development of the body, admiring nothing so much as bodily prowess; carrying all this to such an extent that a natural and wholesome use of athletic exercise has been fostered into a sort of fashionable athleticism, with all its parasitic professionalism, possessing both soul and body.

And the result has been curiously significant; at one end of the scale neglect of the rudiments of sanitation, the loss of the *corpus sanum*, at the other end the idol worship of athleticism, the depreciation of the intellectual life, and the loss of the *mens sana*.

Are we not then in some danger of drifting into the ways of the Greeks, not in their best days but in their decadence, and of the Romans under the demoralising influences of the Empire?

The Greeks, as we are constantly reminded, in the great period of their creative influence, found nothing so absorbing as the things of the mind; a preeminent characteristic of their life was their love of knowledge, their fine curiosity, their enjoyment of the things of the imagination and of thought. It has been noted that what specially conciliated an Athenian voter was the gift of a theatre ticket; and this is a very instructive and significant fact when we bear in mind that the theatre was the great teacher of religion, morals, poetry, patriotism, all in one; that it combined the influences of Westminster Abbey, the plays of Shakespeare, and the heroic achievements of the race; whereas to an ordinary English voter these things are too often only as caviare to the general.

If so, our education has before it the task of doing what can be done to alter this; and from the Greeks we may derive both lessons and warnings. It was in the days when this decadence was beginning that their excessive admiration of the professional athlete, what we might call their athletic craze, called forth the bitter jibes of Euripides, and his impressive warnings and exhortations to admire and to crown with their highest honours, not those who happened to be swiftest of foot or strongest in the wrestling bout, but the man of sound mind, wise and just, who does most to guide others in the more excellent ways, and to uplift the life of his community:

ὅστις ἡγεῖται πόλει
κάλλιστα, σώφρων καὶ δίκαιος ὢν ἀνήρ.

Here we have a warning by no means inappropriate to our own life and its tendencies. It is, indeed, high time to bring serious and, let us say, scientific thought to bear upon the whole matter.

As I look with such thoughts in my mind over those portions of the educational field with which I have been personally familiar, I note various things which seem to call for both consideration and action.

Taking first the elementary school, it is to be noted that our system does too little to draw out and stimulate the faculties or to form the tastes of each individual child.

Classes are still in many cases far too large.

The system of block grants, being inadequately safeguarded or supplemented by inducements to individual children to apply and prepare for certificates of merit or proficiency, however attractive it may be to inspectors and teachers, needs to be very carefully watched in the interests of individual children. The individual child requires the hope and stimulus of some personal recognition or distinction, if its faculties are to be fully roused and its tastes properly cultivated.

Moreover, the aid of scientific thought and experience is needed to bring both the subjects and methods of instruction into closer and more vital relationship with the environment of the children and with their practical requirements, and more weight has to be given to specific ethical teaching, that moral and spiritual training day by day, which has for its end the development and strengthening of character, and taste, and issues in conduct, which is the greater part of life.

And seeing that it is of the essence of any rational or scientific system to avoid needless waste, it is time that our elementary education should no longer be left in its absurdly truncated condition, which allows a child's education to be stopped abruptly and finally at or about the age of twelve, when in the nature of things it should be only beginning. As things are at present, just when the parent of the upper classes is anxiously considering what school will be the best for his son, a vast number of the children of the poorer classes are left by the State to drift out into a wilderness where all things are forgotten.

In this connection, however, it is due to the Board of Education that we take note of the reminders lately issued in the Introduction to the New Code and the memorandum prefixed to the Regulations for the Training of Teachers.

This Introduction to the Code reminds every parent, school-manager, and teacher, very emphatically, that the purpose of the school is to form and strengthen the character and to develop the intelligence of the children, to fit them both practically and intellectually for the work of life, to send them forth with good and healthy tastes and the desire to know, with habits of observation and clear reasoning, with a living interest in great deeds and great men, and some familiarity with, at all events, some portion of the literature and history of their country; and this being so, the special charge and duty of their teachers is by the spirit of their discipline and of their teaching, by their personal example and influence, to foster in the children, as they grow up in their hands, habits of industry, self-control, endurance, perseverance, courage, to teach them reverence for things and persons good or great, to inspire them with love of duty, love of purity, love of justice and of truth, unselfishness, generosity, public spirit, and so not merely to reach their full development as individuals, but also to become upright and useful members of the community in which they live and worthy sons and daughters of the community to which they belong.

Hardly less valuable, as a contribution to education which shall be more thoughtful than hitherto, is the memorandum prefixed to the new Regulations for the Training of Teachers.

I confine myself to one significant quotation from this valuable document:

"Much of the instruction which is given in all subjects must necessarily be founded upon the statements and the experience of other persons; but every education which deserves to be called complete must include some training of the student in those systematic methods of inquiry which are necessary for any assured advance in knowledge, and which are the most truly educative of all mental processes.

"If this scientific spirit is to find its right expression in

the teaching given in elementary schools it must be made to imbue the whole study of the intending teacher during his course in the Training College. It must not be confined to any one branch of the curriculum. It is true that, partly as the result of tradition and partly from other reasons, the term 'scientific method' has come to be associated more particularly with the study of natural phenomena. But as a matter of fact, scientific method is of equal importance, and is indeed of ancient application, in the fields of history, literature, language, and philosophy; and wherever knowledge of these has made advance, it may be discerned that the essential processes of scientific inquiry have been employed. When Matthew Arnold declared in 1868 that the want of the idea of science, of systematic knowledge, was the capital want of English education and of English life, he was thinking of science as a method and not as a prescribed portion or subject of a curriculum. It cannot be doubted that this want has been seriously prevalent in a large portion of the education and training hitherto provided for elementary school teachers."

We might, indeed, widen the scope of these observations and say that this want of regard for scientific method has been and is a prevalent want in almost every department and grade of English education.

These unaccustomed utterances from Whitehall may very well prove memorable in the history of English education, as the words of William von Humboldt, quoted by Matthew Arnold, are so memorable in connection with the education of Germany: "The thing is *not* to let the schools and universities go on in a drowsy and impotent routine; the thing is to raise the culture of the nation ever higher and higher by their means."

Passing from the sphere of the elementary schools to that of secondary education, we enter on a sphere in which there is much greater need of careful study and the guidance of those who know.

Our secondary education has by the Act of 1902 been handed over very largely to county councils, excellent but heterogeneous bodies, and for the most part not only ignorant of educational needs, methods, and possibilities, but quite unaccustomed to their practical consideration—altogether unprepared and untrained for the responsible work now thrown upon them, and hampered by their besetting fear of the ratepayers.

Add to these difficulties the prejudice, so common in the ordinary English mind, against what is known as the "expert," that is, the man who knows from experience, and is therefore likely to be earnest for improvement, and to believe that wise educational expenditure will repay itself, and you see how manifold are the obstacles in the way of immediate progress.

These county authorities need first of all to be themselves instructed and persuaded as to the right subjects for their schools, the coordination or proportion of subjects in any scheme to be encouraged, the methods of instruction, the sort of teachers to be appointed, the wisdom of spending public money on good education, as exemplified in other countries, like Germany, Switzerland, the United States, Denmark.

Our local authorities feel and recognise that something is needed, but very often they seem to be like children crying in the dark. From lack of educational knowledge and educational experience they do not always know the difference between the right and the wrong method, or between the good and the bad school.

In our rural districts at all events it may be said further that one of our first needs is to persuade the local authorities by some convincing proof that expenditure on popular education higher than elementary is a wise economy, and that their bread cast on educational waters will come back to them, not after many days, but very soon and in their own homes. Thus my observation has led me to the conclusion that by way of preliminary to progress our new educational authorities need instruction or persuasion as to the importance of a sufficient provision for really good secondary education; and it would greatly expedite progress if the Government could and would offer more liberal secondary education grants to be earned by efficient schools, and initial grants towards buildings and scientific equipment, to be met by contributions from local rates or other local sources, public or private.

Many persons and localities would be ready to tax themselves with the view of securing a Treasury grant not available without such taxation. Meanwhile the wheels of our local educational chariots are tarrying on every side so far as higher education, whether general or technical, is concerned.

It would also stimulate our local educational authorities if they could be more fully informed as to the practical advantages which have been derived from a practical system of popular education in such a country as the United States of America; and still more if they had set plainly before them the wonderful results derived by a poor country like Denmark during the last twenty-five years, and in the face of every disadvantage, from the system of education initiated by Bishop Grundtvig and taken up by the Government.

And the need of our middle classes, especially that of the farmer and tradesmen classes, is very pressing. A great deal of the education they receive is given in schools of which the public know very little, whether as regards qualifications of the staff—moral and intellectual—equipment, or methods of teaching, or even sanitary arrangements; and it is to be feared that much of this education would on inquiry be found to be very poor, if judged by any reasonable standard of modern requirements.

When we pass to the class of schools generally spoken of as public schools, those that look to the ancient Universities as the goal of their best pupils, we enter on another very interesting and important field of study.

But for the beginning of our investigation we have to go behind these schools to the preparatory school, which has now assumed a definite place in secondary education, and therefore calls for serious attention. Some of these schools are very good, so far as the conditions under which they work admit of excellence; in others there is, it is to be feared, much room for improvement.

And such schools are now so largely used by parents that their condition becomes a matter of vital importance, as a boy's progress and prospects, his moral and intellectual future, are very frequently determined for good or ill by his experience in the preparatory school, by the bent which has there been given to his morals, tastes, ambitions, by the fostering of his intellectual gifts or the failure to foster them.

In the course of my own experience I have known many boys whose prospects in life were spoilt by their unhappy beginnings in some preparatory school, and who consequently entered their public school foredoomed to failure.

These schools are in most cases private-adventure schools, conducted for private gain. Their staff consists very often of young men untrained for the work of education, and sometimes underpaid. They are subject to no public inspection or examination; in fact, the general public have no knowledge of their condition.

Seeing how grave are the considerations involved, I hold it to be one of the things needed for the general improvement of our secondary education that every private school, of whatever kind, should be liable to public inspection and public report thereon; that a licence should be required for every such school; and that the staff and their qualifications, and the remuneration given to each of them, the sanitary condition, suitability, and educational equipment of the premises, should all be considered in connection with the giving or withholding of a licence.

As regards the curriculum of the schools preparatory to the public schools, the subjects taught, and the proportion of time allotted to each, it has to be borne in mind that they are not free agents. In this respect they are dependent on the requirements of the entrance examination at the public schools which they supply; just as those schools in their turn are dependent on the requirements of the university to which they send their pupils.

Thus, when we come to confer with the authorities of the public schools our first inquiry is whether their entrance examination is such as to conduce to the best system of education from infancy upwards.

Believing, as I do, that there is room for improvement, I would ask them to consider and come to a general agreement as to the subjects on which special stress should be laid. What place, for instance, is occupied in the Eton entrance examination by such subjects as English language and literature, English composition, spelling, handwriting,

and reading aloud? What weight is given to elementary drawing, or to an elementary knowledge of natural phenomena, so as to encourage in the preparatory school an interest in the mineral, vegetable, and animal world around us, and to stimulate in early years the habit of observation, and to impress the difference between eyes and no eyes?

Such subjects as these, it is now generally recognised, ought to be given a foremost place and equal weight with the modicum of arithmetic, French, and ancient languages, which have hitherto, as a rule, formed the staple of this entrance examination, and have consequently given an unnatural twist to the earlier education of our boys.

As regards the public schools themselves, if we consider them critically—though, on the other hand, I trust, by no means forgetting their many and great excellences—the points that invite attention would seem to be such as the following :—

There is undoubtedly a great deal of waste in these schools owing to the poor teaching of untrained masters, who in some cases cannot even maintain reasonable discipline, and in many more have no real knowledge or mastery of the best methods of teaching their subject, be it linguistic, or historical, or literary, or scientific, and have not acquired that first gift of an efficient teacher, the art of interesting their pupils and drawing out their faculties and their tastes.

It would, therefore, be reasonable, as it would certainly be stimulative and advantageous, to require that all masters should be bound to go through some system of well-considered and serious preparation or training for the teacher's work, or at the least a probationary period.

It should, I venture to think, be made a rule that no master could be placed on the *permanent staff* until he was certified and registered as having fully satisfied this requirement and given proof of his efficiency.

And here I would venture to point out to existing masters and mistresses in the leading schools how great a service they may do to the cause of good education if they themselves apply to be registered.

Seeing the advantages which registration is destined to bring to our secondary education by winnowing out inefficient teachers and otherwise, the higher members of the profession may fairly be expected to give their personal adhesion to it as a part of their duty to their profession.

We might almost say to them *noblesse oblige*.

Again, it must, I fear, be admitted that one of the chief defects in our public school education is still to be found in over-attention to memory work, and in the comparative failure to develop powers of thought, taste, and interest in the things of the mind.

And even in the teaching of languages attention has been too exclusively devoted to mere questions of grammar, as if to learn the language were an end in itself, whereas, in the words of Matthew Arnold, "the true aim of schools and instruction is to develop the powers of our mind and to give us access to vital knowledge."

For this end, as he reminds us, the philological or grammatical discipline should be more consciously and systematically combined with the matter to which it is ancillary, the end should be kept in view; whereas nine out of ten of our public-school boys seem never to get through the grammatical vestibule at all; and yet we agree that "no preliminary discipline should be pressed at the risk of keeping minds from getting at the main matter, a knowledge of themselves and the world."

This also was written by Mr. Arnold thirty-six years ago, and thoughtful critics are still repeating, and with some reason, that the majority of boys who grow up in our public schools seem hardly to have received an adequate training for many of the higher duties of life.

We hear much more than formerly about the public schools being the best training-place for good citizenship. Therefore, say the critics, it is reasonable to inquire how far their educational system, their ideals, their traditions, their fashions, and the pervading spirit of their life fit the mass of their pupils intellectually and otherwise for the duties of citizenship, and for grappling in the right spirit with the problems that will confront them.

"Any careful observer," says one of these writers, himself a loyal public-school man, and intimately acquainted with school life, "any careful observer, who has studied the political moods and opinions of the middle classes in this country during the past few years, can hardly have failed to notice two obviously decisive influences: an ignorance of modern history and a want of imagination. For both of these defects the public schools must bear their full share of blame.

"It may be doubted whether any other nation teaches even its own history so little and so badly."

The result is that "to the average public school and university man the foreign intelligence in his daily paper is of less interest than the county cricket; and though events of far reaching importance may be happening almost under his eyes he is in the dark as to their significance."

"As regards the duties and aims of citizenship in all the various affairs of his own country, political, social, economic, he goes out from his school almost wholly uninstructed by the lessons of history, or by any study of the life and the needs of our own times. Again, as it is urged, the lack of imagination is hardly less dangerous to us than lack of instruction in the lessons of history and the social conditions and needs amongst which we have to live and work. No doubt the gift of imagination is a natural gift—it cannot be created. But, given the thing in the germ, it can be stimulated and developed, or starved, stunted, or even crushed out. No system of education that neglects it is even safe. For, without it, principle becomes bigotry and zeal persecution. It is conscientiousness divorced from imagination that produces Robespierres. Now, it is precisely here that we should expect the public schools to be most helpful, for it is through literature that the faculty is most obviously cultivated, and they all profess to give something of a literary training. But though the intention is excellent the performance is often terribly meagre." Whatever may be thought of such criticisms as these, which come from within our public-school life, it is, I imagine, generally agreed by those who know both our national needs and the work and influence of our public schools, that there is much room for improvement in regard to methods of teaching, the cultivation of intellectual interests and tastes, and the stimulating habits of thought in the majority of their pupils. In close connection with these considerations there are two questions of practical importance which deserve a prominent place in any study of our public-school education.

The first of these is whether it is good for all boys alike to continue their life at school, especially at a boarding school, up to the age of eighteen or nineteen; and the other is whether more encouragement and pains should not be given to developing the best type of day school, or, to put it somewhat differently, whether the barrack life of the boarding school has not, through fashionable drift and class prejudice, become too predominant a part of our English education at the expense of the home life with all its finer educational influences.

As regards the first of these questions, it will be remembered that Dr. Arnold considered it a matter of vital importance to expedite the growth of a boy from the childish age to that of a man.

In other words, the boy should not be left to grow through the years of critical change from fourteen to nineteen without special regard to his growth in intellectual taste and moral purpose and thoughtfulness. His education during these critical years should be such as to rouse in him the higher ambitions of a responsible manhood.

Does, then, the actual life of a public school really conduce to this early development in the majority of cases?

My own experience has led me to the conclusion that it cannot be confidently held to do so.

The boys in any of our public schools may be said to fall into two classes—those who in due course reach the sixth form, and during their progress through lower forms have an ambition to reach it; and, on the other hand, a numerous class who do not expect to rise to the sixth, don't care about it, and never exert themselves to reach it.

For the first class, I doubt if any more effective preparation for life has been devised than that of our best English schools; but the case of the second class is somewhat different.

Many of these come to the end of their school time with their intellectual faculties and tastes and their sense of responsibility as men to a great extent undeveloped.

From sixteen to eighteen or nineteen their thoughts, interests, and ambitions have been largely centred in their

games and their out-of-school life, with the natural results that their strongest tastes in after life are for amusement and sport.

Some of these boys, after loitering at school to the age of eighteen or nineteen, go to the University as passmen, some begin their preparation for the work of a doctor or a solicitor, and many go straight from school into City life as men of business; and nearly all of them suffer from the lack of intellectual and moral stimulus during these later years of their school life.

Now many of these boys could without difficulty pass the entrance examination to the University at sixteen or seventeen, if well and carefully taught; and I have long held the view that such boys would greatly benefit by going to Oxford or Cambridge at the age of seventeen, or even sixteen, if suitable arrangements could be made.

It was with this conviction in my mind that I published a scheme showing how this experiment might be tried about twenty years ago.

The interval has confirmed me in the opinion that it would be a distinct gain to many boys to take advantage of such a scheme if made available. They would go out into the world from the University at the age of twenty far better equipped and prepared for life, both as regards knowledge and interests, tastes, and character, than by going straight from school at nineteen.

And looking to my own University of Oxford, I see no reason why such younger students should not be safely received.

There are at least three Colleges in that University which would find it easy to adapt their arrangements so as to secure this. Each of these Colleges has a hall in connection with it, well suited for the residence of a college tutor who might have special charge of these younger students, residing in the hall during their first year with somewhat stricter rules as to ordinary discipline and liberty, but in all other respects exactly on a par with the senior undergraduate members of the College.

On the subject of the day school, as compared with the boarding school, a subject which has not hitherto received the attention it deserves, I may venture to repeat here what in substance I have said on other occasions.

Many parents are so situated that they have no choice in the matter; but to the educational inquirer it is a question of much interest and importance.

The boarding school is admitted to excel in turning out strong, self-reliant, sociable, practical men of affairs, men who have learnt by early experience not to think or make too much of small injustices, to rough it, if need be, with equanimity and cheerfulness, and to count it a man's part to endure hardness in a manly spirit. It is a fine type of character which is thus produced, at its best; but the best is not always seen in the result, and the system too often produces an undue deference to public opinion, a spirit of moral compromise, and a loss of moral enthusiasm. The human soul in its finer parts is a very sensitive thing, and I do not think the barrack life of an average boarding school is always the most favourable for its healthy growth.

As I look back over the school days of my own pupils I feel that those of them had, on the whole, the best education who grew up as day boys in good homes at Clifton College. There they enjoyed all the advantages of the cultivated home, which I need not here enumerate, and at the same time, through the arrangements we made for them, all the best elements in the life of a great boarding school.

In the upper school of 500 boys, we had about 160 day boys living at easy distances from the school.

These boys were divided into two houses—North Town and South Town—about eighty boys in each house, and they were treated for school purposes just as if they were living together in a boarding house.

They were under the same rules as boarders in regard to hours of locking up, or the bounds beyond which they might not go without a note from their parents giving express leave.

Their names were printed in a house list, a master was appointed as their tutor, whose duty it was to look to their educational needs and progress, to their reports and conduct, just as if they had been boarders and he their house master. Each house had its own room or library on the College premises, with books of reference, and so forth, for spare hours, and took its part with the boarding houses, and held its own in all school affairs, games, and other competitions. And my experience of this system compared with others has led me to the conclusion that the form of education which may on the whole claim to be the best is that of a well-organised day school, in which it is clearly understood to be the duty of the masters to give their life to the boys in school and out of school, just as if they were at a boarding school, and in which the boys are distributed into houses for school purposes, just as if they were living in a boarding house. Under such a system they get the best of both worlds, home and school.

From the public school we pass naturally to the Universities, and the first question that meets us is the influence they exercise on school education, through their requirements on admission or matriculation and the bestowal of their endowments and other prizes.

On this part of my subject I have seen no reason to alter or modify what I said at Glasgow three years ago, and therefore I merely enumerate and emphasise the suggestions which I put forward on that occasion for the improvement of education both at school and college.

I hold that it would be equivalent to pouring a new stream of intellectual influence through our secondary education if Oxford and Cambridge were to agree on some such requirements as the following:

(1) In the matriculation examination (*a*) candidates to be free to offer some adequate equivalent in place of Greek.

(*b*) An elementary knowledge of some branch of natural science, and of one modern language to be required of all candidates.

(*c*) A knowledge of some period of English history and literature also to be required of every candidate, and ability to write English to be tested.

(*d*) The examination in Latin and any other foreign language to include questions on the subject-matter of any prepared books offered, some questions on history and literature, and translation of easy passages not previously prepared.

(*e*) Marks of distinction should be given for work of superior merit in any branch of this examination, as, indeed, of every pass examination conducted by the University.

Candidates should not be excluded from residence before passing this examination, nor should they be required to pass in all subjects at the same time; but the completion of this examination would be the necessary preliminary to entry for any other examination required for a degree.

(2) On the question of endowments and the minimising of waste in the administration of them there is much to be said, and I would suggest for consideration:

(1) That, as a rule, open scholarships and exhibitions might be reduced to free tuition, free rooms, and free dinners in hall, or thereabouts.

(2) That every holder of an open scholarship or exhibition, whose circumstances were such that he needed augmentation, should, on application, receive such augmentation as the College authorities considered sufficient.

(3) That care should be taken to discourage premature specialisation at school.

For this end it should be required that no scholar should enjoy the emoluments of his scholarship until he had passed the matriculation examination described above; and a fair proportion of scholarships should be awarded for excellence in a combination of subjects.

The Universities might also do good service in the way of stimulating secondary education, if some small proportion of their entrance scholarships were distributed over the country as county scholarships, on condition that the county contributed an equal amount in every case.

In this way some equivalent for the endowments, so cynically confiscated by the Education Act of 1902, might be recovered and used for the benefit of poor and meritorious students.

Other reforms, which would, as I believe, be productive of valuable results, are the requiring from every candidate for a degree a knowledge of some portion of our own literature and history, and the encouragement of intellectual interests and ambitions by abolishing all purely pass examinations. A pass examination, in which the candidates are invited simply to aim at a minimum of knowledge or attainment, is hardly worthy of a university. The opportunity

of winning some mark of distinction in this or that portion of what is now a pass examination would frequently rouse some latent ambition in an idle man, and transform the whole spirit of his work.

Thus a modest reform of this kind might be of great practical benefit to the nation by helping in its degree to intellectualise the life of a great many of our young men, and draw out unsuspected interests, faculties, and tastes.

My observations have run to such a length that I must, perforce, conclude, leaving untouched other aspects of University education and training, whether in the old or the new universities, as also the whole subject of the higher education of women, and its proper relationship to traditional systems of instruction and study, framed and intended for men.

And my last word is a word of practical inquiry. How is this Section to be made of most value as an instrument of educational progress?

I leave the answer to this question to those more competent to give it, merely putting on record my own feeling that it may do a valuable service and supply one of our special educational needs, if the working committee of the Section, enlarged by the addition of various representative persons, makes it a duty to collect and publish year by year in succession a series of papers, the best that can be written by recognised authorities, on the chief branches of our English education, dwelling on its immediate and pressing needs, and how best to supply them. To do this the Committee should set to work systematically, commencing in October with monthly meetings, and formulating, without delay, the scheme or series of papers to be prepared and presented to the next meeting of the Association.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Dr. H. Burrows has been appointed to the post of lecturer and demonstrator of chemistry at the Sir John Cass Technical Institute, Aldgate.

A conference of delegates appointed by the Welsh county councils to discuss the question of afforestation in the Principality was held at Swansea on September 7. Sir Charles Philipps, who presided, remarked that there was in Wales an enormous area which could be profitably afforested. It was necessary that professors of the subject should be appointed at the universities, and that practical demonstration areas should be set apart. The view was expressed, in course of discussion, that the establishment of a central school of forestry for Wales was of the utmost importance, and that such a school would become self-supporting after a few years. It was at length resolved that the members should urge on their respective councils the great importance of the study and practical application of forestry by providing lectures to be given at suitable centres and bursaries, enabling students to attend these lectures; also that a central school of forestry be established with example plants of three or more acres, and demonstration areas of suitable extent, and that the necessary expense be defrayed by the county councils on the basis of their respective rateable values, the whole amount now asked for not to exceed 5000*l*.

Addresses will be given at most of the medical schools on the occasion of the opening of the winter session early in October. At Charing Cross Hospital, the session will be opened by the delivery of the fifth biennial Huxley lecture, on "Recent Advances in Science and their Bearing on Medicine and Surgery," by Sir William MacEwen, F.R.S. At the St. George's Hospital an introductory address on "Some Landmarks in the History of Medical Education" will be given by Prof. A. Macalister. The opening meeting of the Physical Society of Guy's Hospital will be held on October 8, when Sir Samuel Wilks, F.R.S., will preside. At King's College Hospital Dr. Thomas Buzzard will deliver an address on "The Future Relation of King's College to its Medical School and Hospital." At St. Mary's Hospital the introductory address will be delivered by Prof. A. E. Wright. At the Middlesex Hospital the session will open with an introductory address by Dr. F. J. Wethered. At University College, London, an introductory address will be given by Prof. J. Norman Collie, F.R.S. The introductory address in connection with the opening of the winter session of the London (Royal Free Hospital) School of Medicine for Women will be delivered by Miss Murdoch at the Medical School on October 3. At the Pharmaceutical Society the inaugural sessional address will be delivered by Prof. A. W. Crossley.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 9.—M. Mascart in the chair.—On a gaseous interrupter: K. R. **Johnson.** The interrupter consists of two plates of aluminium placed in a solution of an electrolyte. The heating effect of the current evolves a bubble of steam, which temporarily breaks the circuit; this is rapidly condensed in the upper part of the cell, and so causes a series of makes and breaks. It has the advantage of working independently of the dimensions of the metallic circuit, and even in the absence of an induction coil or a solenoid. Its disadvantage is that the frequency is rather low.—On a reagent for the hydrides of phosphorus, arsenic, and antimony: P. **Lemoult.** These gases, when diluted with an inert gas, react with a solution of the double iodide of mercury and potassium, giving characteristic crystalline precipitates, orange, yellow or brown in colour. They have been analysed, and correspond to the formula RHg_3I_3, in which R may be P, As, or Sb.—Benzopinacone and benzopinacoline: Amand **Valeur.** Evidence is given that the compound obtained by W. Dilthey and E. Last by the interaction of ethyl oxalate and phenylmagnesium bromide is a pinacone and not a pinacoline as supposed by them.—The synthesis of estragol and aromatic derivatives with an unsaturated chain: M. **Tiffeneau.**—On the reproductive apparatus of the Mucorinæ: J. **Dauphin.** Glucose, levulose, and galactose favour the appearance of sporangia; lactose and saccharose give only sporangia and chlamydospores; maltose and mannite give uniquely chlamydospores.—On macles: G. **Friedel.**—The relations between the blood circulation and the measurement of tactile sensibility: N. **Vaschide.** It is shown that there is an extremely close relation between the circulation of the blood and the tactile sensibility.

CONTENTS.

THURSDAY, SEPTEMBER 22, 1904.

THE SCOPE OF ANTHROPOLOGY.

Science de l'Homme et Méthode anthropologique. By Alphonse Cels. Pp. vi+467. (Paris: Félix Alcan; Bruxelles: J. Lebègue et Cie., 1904.) Price 7 francs.

THERE has always been a great difference of opinion about the scope of the science of anthropology. Huxley's view was that anthropology deals with the whole structure, history, and development of man. Another authority subdivides the subject as follows: (1) Man's place in nature, *i.e.* his relation or standing to the animal kingdom as a whole; (2) his origin, whether from one pair or otherwise; (3) classification of races, with delineation of their chief characteristics; (4) antiquity of man; (5) language; (6) development of civilisation as a whole. Mr. Fallaize, in a paper read last year before the Anthropological Institute, has given the following main subdivisions:—(A) man's place in nature; (B) physical structure; (C) physical functions; (D) specifically human activities; and makes divisions (2) and (3) of the previous classification subdivisions of his class (A).

These examples will illustrate the wide variety of opinions held by authorities about the scope and the method of classification of the subject-matter of anthropology. The impression one gets from the consideration of these schemes is that it is not within the capacity of any one man to be an anthropologist in the widest sense of the term. The definitions of the scope of anthropology given above include many separate sciences, such as anatomy, physiology, philology, archæology, which in themselves are sufficient to absorb the energies of any single student, and which were in existence before the science of anthropology was created. Many branches of the study of man must therefore as a matter of practical convenience be abandoned to special sciences, and if a science of anthropology is to have any *raison d'être* it must be content to take the results of the studies of the anatomist, the physiologist, the psychologist, the archæologist, &c., and to coordinate and correlate these results with the view of discovering the more general laws of human nature.

The sciences at present generally included among anthropological studies have not been created by a subdivision of the whole subject-matter relating to man into watertight compartments, but usually some end of special theoretical or practical interest has formed a centre around which the science has been built up. For example, the interest excited by the perception of the great differences in the characteristics of different races has led to the creation of the science of ethnology, and the object of this science is to utilise all knowledge which may throw any light on the question of race. It overlaps without completely including prehistoric archæology, anthropometrics, psychology, and many other sciences.

This appears to be the only practical way of studying anthropology, but there can be no doubt that a great deal might be gained by the careful setting out of the whole of the subject-matter which, in the widest sense, could be taken as included in a complete science of man. New subjects of study which were previously overlooked may in this way be suggested, and new subordinate sciences created.

This very useful work has been well done by M. Cels in the book under review in a very suggestive though somewhat diffuse and fanciful style. About one-half of the book is devoted to an exposition of the logical methods of science, and as these methods are not more specially applicable to anthropology than to any other science, this part of his work might very well have been omitted or given in a much more condensed form. The same information might be found in any modern treatise on logic.

When we come to the part of M. Cels's work which is more especially relevant to its title, we find his subdivision of the subject-matter of the science of man interesting, suggestive, and well worth the attentive study of anthropologists.

Anthropology, according to M. Cels, is to be divided in the first place into two main subdivions, namely, the study of the nature of man and the study of the life of man, *i.e.* man is to be studied from the static point of view and from the dynamic point of view. In the second place, each of these main divisions is again subdivided into the study of the intrinsic and extrinsic conditions of their existence. Finally, each of these four subdivisions is again subdivided into three, in the first of which man is regarded as a Unity, *i.e.* as an individual, in the second as a Duality, *i.e.* as made up of body and mind, and thirdly as a Harmony, *i.e.* as a bisexual being which is only completed by the union of the two sexes for the reproduction of the species.

This division of the subject-matter of anthropology appears in some respects a little fanciful, but it is very plausibly worked out by M. Cels in his treatise. The author's view of anthropology is that it includes the study of the body and the mind of man, in their constitution as well as in their activity. This part of the subject is fairly well covered by the existing sciences of anatomy, physiology, and psychology. M. Cels also emphasises the necessity of studying the environment of man, namely, the earth on which he lives, his fellow-men and lower animals, and any other influence which reacts on his organism and on its activity. The effects of the moral as well as the material environment must be studied. The study of the influence of environment on mankind has not received so much attention from anthropologists as it deserves.

As a matter of practical convenience, the detailed study of the body and mind of the individual man must be abandoned to anatomy, physiology, and psychology; anthropology can only concern itself with the coordination of the results of these sciences. It may compare the anatomy, physiology, and psychology of different races of contemporary men, or of men of the present with those of the past. This field is to a great extent covered by physical anthropology, prehistoric archæology, the study of culture, and experimental psychology.

Though M. Cels has devoted so large a part of his work to the logical methods of anthropology, he tells us little or nothing of the immense advance that has been made in recent years in anthropometrics. No science makes much progress until precise measurement is applied to the characters the distribution and correlations of which are to be ascertained. Measurement has been applied to the body of man for more than fifty years, but only within the last few years has a statistical method been devised which enables us to give the true interpretation of the vast amount of anthropometric statistics that has been accumulated. But the work of Galton and Karl Pearson receives no notice from M. Cels in his work on the science of man and anthropological method; we are referred rather to the works, published fifty or more years ago, of Cuvier, Krause, and Saint-Hilaire, whose ideas on co-relation were mere shadows of the precise knowledge we now possess.

As a highly abstract and suggestive exposition of the nature and scope of anthropology, the book deserves a place in the library of the anthropologist.

J. GRAY.

PROGRESS IN THE CHEMISTRY OF FATS.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch, M.A., F.I.C. Third edition, re-written and enlarged. Two vols. Pp. xxviii + 1152. (London: Macmillan and Co., Ltd., 1904.) Price 36*s*. net.

IN this, the third edition of Dr. Lewkowitsch's well known work, there is naturally much that was not included in the former issues. And since the second edition was itself a somewhat bulky tome of more than eight hundred pages, the author has wisely divided the present work into two volumes, corresponding broadly to the analytical and technological branches into which his subject resolves itself.

Briefly, the first volume deals with general principles, the second with individual products. In the earlier chapters there is a discussion of the theory of saponification, and a description of the glycerides, esters, alcohols, and acids which form the proximate constituents of oils, fats, and waxes; the rest of the first volume is mainly devoted to an account of the chief physical and chemical methods now employed in the examination of these substances. In the second volume, after a short generalised description of their commercial methods of preparation, the individual oils, fats, and waxes are dealt with. Under each article are given its source, characteristic features, physical and chemical constants, and such miscellaneous information as the technical uses of the product and the nature of its probable adulterants. Finally, the last two chapters embody an account of modern manufacturing processes employed in the various industries soap, candle, rubber, glycerol, and so on—for which the raw materials are furnished by oils and fats.

To specialists, the foregoing summary will show the present arrangement of what is now the standard English book of reference on the subject. To chemists who have not followed the progress of the chemistry of the glycerides very closely it may be useful to indicate a few of the more recent developments which, among many others, Dr. Lewkowitsch has described or referred to in the book under review.

Looking back over the work of the last few years, what strikes one as being the most notable advance in the chemistry of fats is the recognition of mixed glycerides as frequent if not normal constituents of fats and oils. Since the days of Chevreul, until quite recently, these latter bodies have been almost universally regarded as mixtures of simple triglycerides —usually trioleïn, tripalmitin, and tristearin. True, evidence was adduced more than a quarter of a century ago, on the one hand by Bell and Lewin, and on the other by Blyth and Robertson, which pointed to the fact that butter-fat contained a mixed glyceride, oleopalmitobutyrin. But, probably owing to the difficulty of isolating and definitely proving the identity of such compounds, the observation long remained almost unnoticed. During the last few years, however, the mixed glyceride oleodistearin has been obtained by Heise from kokum butter, stearopalmitin by Hansen from tallow, oleopalmitostearin and oleodipalmitin by Klimont from cocoa-butter, and daturodistearin by Kreis and Hafner from lard. This does not exhaust the list; and, indeed, the probability is that on further investigation mixed triglycerides will be found in most oils and fats. Several have also been synthesised, chiefly by Guth; thus two isomers of stearodipalmitin have been prepared, the α variety from α-monostearin and palmitic acid, and the β form from α-dipalmitin and stearic acid.

Another point of interest is the frequent, and perhaps general, occurrence of fat-splitting enzymes such as steapsin in both vegetable and animal oils and fats. The author is strongly in favour of the view that the rancidity of fats is due initially to hydrolysis of the glycerides by these ferments. To this, however, one possible objection suggests itself. Enzymes are usually destroyed at moderately high temperatures—*e.g.* maltase at 80°. Is there any evidence to show that lard or tallow prepared at steam-heat, or any fat specially raised to a temperature of, say, 95° to 100°, does not turn rancid? If it does not, so much the better for the enzyme theory of rancidity. If it does, one would still like to have other evidence that the enzymes present are capable of withstanding these higher temperatures.

As regards the analytical chemistry of fats, the most important among recent advances is undoubtedly Hehner and Mitchell's method of determining stearic acid. It is not an ideal process, and shows at least one anomaly; but it does place in the chemist's hands a valuable and long-wanted means of estimating, with reasonable accuracy and expedition, the proportion of one of the most frequent constituents of natural glycerides. To the same investigators, following Hazura, is also due the working out of what promises to be a very useful aid to the study of unsaturated glycerides, namely, the quantitative determination of their hexabromide derivatives. Of new methods having an immediate value to the practising analyst there may be mentioned Bömer's phytosterol test for vegetable oils, and Polenske's process for detecting

cocoa-nut oil in butter. No reference, however, is made to the Muntz and Coudon method of estimating the latter adulterant.

These are but a few out of many points of interest which one notes on looking through the book. A number of new illustrations appear, including some, which might be improved upon, of lard, cholesterol, and phytosterol crystals. There are plenty of references to original sources, and the information generally is brought well up to date, several papers issued in the present year being laid under contribution.

"Adulteration," says Dr. Lewkowitsch, "has almost become a fine art." No doubt it has; and in the silent, ceaseless struggle between the cunning of the adulterator and the skill of the analyst such works as the present play an important part. They are very helpful to the former individual, certainly. But to the latter they are invaluable. C. SIMMONDS.

STOKES'S MATHEMATICAL AND PHYSICAL PAPERS.

Mathematical and Physical Papers. By the late Sir G. G. Stokes. Vol. iv. Pp. viii+378. (Cambridge: The University Press.) Price 15s.

IT was on all grounds fitting that the continuation of this reprint should be entrusted to Prof. Larmor. The energy with which he has addressed himself to the work is shown by the fact that, although it is little more than a year since the death of his great predecessor, we already have a new volume in our hands, containing, in addition to the text, some valuable annotations and a selection from some very interesting correspondence.

The papers here reproduced range in date from 1853 to 1876; they are about forty in number, and, as a rule, are shorter and more restricted to special points than is the case in the previous volumes. There are, however, some notable exceptions. From the mathematical point of view the most considerable is the memoir "On the Communication of Vibration from a Vibrating Body to a Surrounding Gas." Perhaps the highest testimony to the excellence of this investigation is that Lord Rayleigh, who usually transforms and illuminates what he touches, in this case found, as he tells us, no better course open to him than to print page after page *verbatim* in his "Theory of Sound." The memoir is important, historically, not solely for the interest of the particular phenomenon which it explains, but as leading the way for a whole series of investigations in acoustics, optics, and electricity, in which we have to deal with waves diverging from point- or line-sources. Especially characteristic of the author is the labour expended with a view of reducing the results to a definite numerical form. From another point of view the paper may be regarded as forming one of the long series (some other members of which fall in the present volume) in which Stokes attacked the difficulties of the Bessel functions; other methods of dealing with these have since been devised, but it is mainly through his labours that these functions have become real and intelligible instruments of the mathematical physicist, instead of merely abstract analytical expressions.

We also find in this volume the classical "Report on Double Refraction," presented to the British Association in 1862. This has entered into so many discussions, that it is unnecessary to refer to it in detail. Although elastic theories of light no longer excite the same interest, the report is still worthy of careful study, not only on intrinsic grounds, but also as a masterpiece of criticism, and as an embodiment of the clear and judicial mind of its author.

Among experimental investigations, we may note the very important paper "On the Long Spectrum of the Electric Light," and the verification of Huyghens's law of refraction in uniaxal crystals, which has served as a touchstone of optical theories.

A short, but extremely acute, paper "On the Effect of Wind on the Intensity of Sound," read before the British Association in 1857, was unfortunately unnoticed and forgotten until the explanation was rediscovered, and extended so as to include the effect of variations of temperature, by Osborne Reynolds in 1874.

It will not be supposed that the numerous other brief memoirs which we are obliged to pass over without special mention are unimportant. To the scientific worker the value of such a collection often resides chiefly in these minor investigations, which are otherwise in danger of being overlooked, as in the instance just referred to.

As has been already mentioned, the editor has appended a few notes, chiefly of a historical character. This delicate task has been exercised with great judgment and restraint. He has also included a most interesting correspondence between Stokes and Thomson on the early history of spectrum analysis. It is clear that long before Kirchhoff's first publication on the question Thomson was in possession of the leading ideas of the subject, and foresaw its wonderful possibilities, and that he had, moreover, publicly expounded these things in his lectures at Glasgow. But whilst he is emphatic that he derived his knowledge from Stokes, the latter is equally positive that his share in the matter was limited to suggestions which he had himself not been able to follow out with the same confidence. The whole correspondence is a lesson of magnanimity on both sides; we feel, as Lord Rayleigh recently expressed it, that the theory of spectrum analysis is practically there, but it would be contrary to the whole spirit of the friendly debate to attempt to analyse further how much of the merit of this prevision belongs to one rather than to the other. One point, however, remains indisputably associated with the name of Stokes, viz. the hypothesis that special absorption of light is due to coincidence, or approximate coincidence, of the period of the light waves with a proper period of a molecule. Hypotheses of this kind have played a great part in recent theories of anomalous dispersion and the like; but there can be no question as to their original source.

The remaining papers are to be included in a fifth volume, together with the biography by Lord Rayleigh recently issued by the Royal Society. We are also

encouraged to look forward to a selection from Stokes's scientific correspondence, which cannot fail to be of the highest interest.

All readers will combine in congratulating Prof. Larmor and the Cambridge Press on the success of this most acceptable volume. The portrait by Dickenson, of date 1874, is admirable; we trust that it may be supplemented later on by a likeness of a more recent date, recalling the aspect which is to many more familiar. HORACE LAMB.

ARGENTINE LIVE STOCK.

Argentine Shows and Live Stock. By Prof. Robert Wallace. Pp. 154. (Edinburgh: Oliver and Boyd, 1904.) Price 3s. 6d. net.

THIS volume is the outcome of a six months' tour of agricultural investigation and inspection in Argentina. While professing primarily to be an account of the annual live stock show of the Rural Society held at Palermo, it includes also notes on other Argentine shows, as well as an interesting description of the chief breeds of cattle, horses, and sheep bred in that country.

The European breeds of cattle represented at the Palermo show were the shorthorn, the Hereford, and the Aberdeen-Angus. Of these, the shorthorn cattle were far the most in evidence. We are told that this breed owes its success to its unrivalled capacity for beef-production where the climate is genial and pasture abundant, and to the fact that it has proved more serviceable than other imported breeds for crossing with the Criollo or native cattle, and so improving their quality for purposes of fattening. Hereford and Aberdeen-Angus cattle are stated to thrive well amid comparatively unfavourable surroundings, and, although not bred to nearly the same extent as the shorthorns, occupy a definite place in the rural economy of the Republic. The Aberdeen-Angus breed has not gained general favour partly because, unlike the other two breeds mentioned, it does not "nick" well with the Criollo cattle.

The horses at the Palermo show included all the more prominent British breeds, the introduction of which has been accompanied by considerable success. It is instructive to note that the importation has in many cases resulted in improvement, apparently owing solely to change of soil and environment. This is especially the case with certain strains of Hackney blood, while among cattle a similar tendency has been noticed for the Hereford breed.

Reference is made to the native Criollo horses, the degenerate descendants, according to most writers, of Barbs and Arabs introduced by the Spaniards at a very early period of the European occupation. Genuine Criollos—only now found in outlying provinces—are characterised by their dun colour, by stripes on the legs and shoulders, and by a dark dorsal band. These Criollos are said to be hardy to a degree, to possess great power of endurance, and, moreover, they are difficult to handle. Doubtless natural selection has been at work eliminating the unfit, with the result that the survivors present all the traits that Darwin and others associated with the ancestors of the common horse. That in the Criollos the mane in no way differs from the mane of Barbs and Arabs suggests that many centuries must have elapsed since horses acquired a long mane, from which it may be inferred that Prjevalsky's horse is not an escaped domestic horse.

It is worthy of note that so great is the vigour of the Criollos that crosses with but little of the native blood prove most useful, owing to their great stamina and endurance.

The section on horses is followed by one on the sheep bred in Argentina. The account includes some interesting information about the early history of the Pampa and Criollo sheep, besides containing suggestions for the improvement of the stock now existing in the country. The Pampa is stated to be derived from the Spanish long-wool, which was a hardy animal, and, like the Dorset Horns of England, in favourable circumstances bred twice a year. The Criollo sheep is a "degenerate offshoot of the Spanish Merino." The most numerous and best represented sheep at the present time are the Lincoln and its various crosses, though a good many other British breeds have been imported with varying degrees of success.

Chapters on dairying and on agricultural machinery follow the description of the live stock.

The book is of value for the interesting descriptions which it contains, and because it affords an idea of the altogether remarkable resources of Argentina for producing live stock. It is freely illustrated by photographs of prize animals taken at the show in Palermo.

OUR BOOK SHELF.

The Old Riddle and the Newest Answer. By John Gerard, S.J., F.L.S. Pp. vi+293. (London: Longmans, Green and Co., 1904.) Price 5s. net.

WE have derived much entertainment from Father Gerard's lively chapters. They constitute an ably constructed plea for agnosticism in science. Not Huxley himself was so rigid in demanding exact demonstration of the truth of every statement required to be believed, as is this latest critic of the doctrine of evolution.

Science does not consist purely of mathematical demonstration. Other methods and processes have a perfectly legitimate place in scientific thought. Even in pure logic a door is open to theory and hypothesis; nor are probability, analogy, or even conjecture excluded by those whose conception of the science and art of reasoning is of the widest and wisest kind. We have, of course, to refrain from treating an untested hypothesis, however likely to be true, as an immutable verity; but no one in his senses will fail to recognise that among the dicta of scientific writers there are many degrees of probability, ranging from the practically certain to the merely conjectural. Some of the conclusions of science are as certain as the nature of things will allow; but it is a mistake to attribute to those who lay stress on such certainty a claim of equal respect for every position that to scientific men appears probable.

All this is, of course, perfectly well known to Father Gerard; we can only say that in practice he appears to disregard it. His book is marked throughout by great charm of style and felicity of expression; its main defect is a too evident desire to "play to the gallery." The chapters which contain a root-and-

branch attack on the theory of genetic evolution are as brightly and easily written as the rest; their matter, however, will be entirely unconvincing to those who know the facts. The author has got up his case as a clever advocate might get up his address to a jury; but the cross-examination of witnesses would put a very different complexion on the whole business. Father Gerard seeks to prove too much. His plea amounts to an allegation in the name of science that a science of life is non-existent. F. A. D.

Occurrence of Aluminium in Vegetable Products, &c. By C. F. Langworthy, Ph.D., and P. T. Austen, Ph.D. Pp. v+168. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 8*s.* 6*d.* net.

After a careful perusal of this book we have been unable to arrive at any conclusion as to why it was written. The authors presumably had some reason for compiling a bibliography of the analytical work done on aluminium and its occurrence in plants, animals, and waters, but they give no idea as to their object in their preface.

The book, as already stated, consists of a compilation of work dealing with the occurrence of aluminium in vegetable products, animal products, and in natural waters. In the preface it is stated that "no attempt has been made to comment on the value of individual analyses cited." Now by omitting to do this the book loses any value it might have had, because the references given are so extremely scanty. One or two examples taken at random will give an idea of the style of compilation, *e.g.* on p. 9 we find:—

"Coppola, M. (*Gaz. Chim. Ital.*, 10, p. 9: *Jour. Chem. Soc.* London, 37 (1880), p. 382), found 11.16 per cent. ash in *Stereocaulon vesuvianum.* Of this 1.13 per cent. was Al_2O_3."

Again, on p. 73:—

"Finckh, C. (*Neue. Jahrb. Pharm.*, 34, p. 13; *Chem. Centbl.*, 1870, p. 615; *Jahresb. Chem. Naumann*, 1870, p. 1382), notes traces of aluminium in Ochsenhausen mineral water from Bieberach, Germany."

Both these illuminating passages are taken from the middle of the respective pages. On p. 73 there are seven and a half such references, and on p. 9 eight.

The contents of the book are not arranged in any order, except that the authors' names are placed alphabetically. Consequently, if one looks up tea in the index in order to ascertain whether it contains aluminium, one is referred to p. 32; after a lot of hunting we find tea under the name of Schriddl, P. (*Arch. Pharm.*, 1873, p. 375). . . . Again, if we wish to know the aluminium content of mushrooms, we are referred to p. 15, where we can find nothing about mushrooms, unless *Boletus edulis* is a mushroom; or is poke-weed the American name for mushroom?

In desperation we look up primrose, and are referred to p. 42, and at last we are satisfied; the root of the primrose contains 1.617 per cent., and the flower heads 1.145 per cent., of aluminium oxide.

Works of compilation are often of great value, but they can only be of value when the contents are systematically arranged. To arrange a dictionary such as this according to the names of the authors is absurd. The pitiable thing about the whole matter is that the authors must have wasted a great deal of valuable time, because a compilation of this kind is extremely tiresome and laborious.

Practical Chemistry. By P. A. E. Richards, F.I.C. Pp. viii+136. (London: Baillière, Tindall and Cox, 1904.) Price 3*s.* net.

So long as examinations in practical chemistry of the test-tube order are encouraged by examining bodies, there will be a steady consumption of chemical cram books. The peculiarities of such books are that the student is never allowed to step outside the limits of his syllabus without due warning, and his weary brain is not perplexed with explanations. Like the cattle in the large tinned meat factories, he is driven along a narrow gangway in which he cannot turn round, until he is delivered into the hands of the slaughterer.

Fortunately the more intelligent examining bodies are beginning to realise that the analysis of simple salts does not furnish scientific pabulum of a very nourishing kind; so preparations of a few inorganic compounds and a little volumetric analysis have been added to the syllabus.

The present volume has been prepared to meet the special requirements of the syllabuses of the conjoint board and the preliminary scientific examination of the London University.

It is only necessary to state that the author has completed his task in a thoroughly business-like manner. A student who worked through the book conscientiously might with confidence defy the conjoint examiner to do his worst. J. B. C.

Calculations used in Cane-Sugar Factories. By Irving H. Morse, B.S. Pp. viii+74. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 6*s.* 6*d.* net.

This collection of tables was primarily made for the use of the sugar chemists of Louisiana, but it is equally applicable to the operations of every manufacturer of cane-sugar. The work may be recommended to all who seek to use the laboratory as a control of the working of the sugar-house. In every well regulated factory the manager is dependent upon the chemist for information as to the amount of sucrose in the raw juice, the yield of sugar, the losses in manufacture, and whether or not all the available sugar is being extracted from the cane, and the efficiency and value of the laboratory largely depend upon the rapidity and accuracy with which this information can be furnished. The work is thoroughly practical, and is evidently the outcome of many years' experience of sugar testing.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

Colours due to Intermittent Illumination.

Mr. C. T. Whitmell (Nature, September 1, p. 424) describes a method of producing coloured patches by means of a rotating disc, furnished with a ring of holes. It will be found that the phenomenon can also be produced by intermittent reflection. In the year 1881 I described in Nature (vol. xxiv. p. 140) a method whereby colour patches of great brilliancy, due to intermittent illumination, were easily produced by viewing sun-light reflected from the polished spokes of a cycle wheel. The relationship between the colour given and the velocity of rotation was clearly marked, and the effects can be easily reproduced by means of the simple apparatus described. In these experiments, a counter was attached to the axle of the rotating wheel, so that the rate of rotation could be accurately determined at the time of observation. The rotation of the cycle wheel was maintained by means of a motor the speed of which could be easily varied. In connection with the phenomenon of the change of colour due to intermittent illumination, several papers of much interest have been published since the year 1882 by Dr. G. Burch, F.R.S. F. J. Jervis-Smith.

Trinity College, Oxford, September 13.

Is Selenium Radio-active?

It occurred to me recently that a possible method of deciding between the two hypotheses which have been brought forward to explain radio-activity, namely, that of *atomic* degradation (Rutherford and Soddy, Ramsay, &c.) and that of *molecular* change (Armstrong and Lowry, *Proc. Roy. Soc.*, 1903), lay in attempting to realise radio-activity in the case of an element well known to undergo molecular change readily, but with an atomic weight small enough to exclude the probability of an atomic instability such as is assumed for radium and thorium. Such an element is selenium (at. wt. 79), which suggested itself to me as a suitable material to experiment with because, under the influence of light, it undergoes a remarkable alteration in its electrical resistance and E.M.F. of contact, suggesting an allotropic change of an altogether unusual character. As this change, whatever be its real nature, occurs almost instantaneously (Bellati and Romanese, *Atti R. Ist. Veneto*, 1881; Maiorana, *Atti dei Lincei*, 1894 and 1896), it seemed possible that the rapidity of the intermolecular vibration might be sufficient to cause a radiation similar to that of radium and thorium which, by "ionising" the selenium, would render it conducting. In order to ascertain whether such a hypothetical radiation could be detected photographically, I exposed a piece of selenium, placed on a photographic plate, wrapped in three thicknesses of black glazed paper, during thirty-six hours to the bright sunshine of July. On developing the plate a distinct black stain on a background of clear glass indicated the position the selenium had occupied. The first experiment was made with ordinary vitreous selenium, and the stain, although distinct, was not very pronounced. A second experiment with freshly prepared "metallic" selenium, obtained by heating the vitreous variety at 190° for half an hour and then cooling very gradually to the ordinary temperature, gave a much more intense stain on the negative.

I should have hesitated before publishing these experiments in their present form had I not, since they were made, seen a paper in the *Physikalische Zeitschrift* of August 25 in which similar results are recorded by J. J. Taudin Chabot. This observer, approaching the subject from a different direction, has also been led to the conclusion that selenium in a selenium "cell" is feebly radio-active to the extent of emitting radiations capable of passing through black paper and affecting a photographic plate. It may, of course, be urged that the stain on the plate is due to selenium vapour penetrating the paper in which the plate is enclosed. I am therefore making experiments in which this possibility is excluded. Further, I intend studying the behaviour of sulphur, as it is already known that the other members of the selenium family, namely, oxygen and tellurium, can in certain circumstances give rise to radio-active phenomena.

W. A. DAVIS.

City and Guilds of London Institute, Central Technical College, S.W.

Rare Moths in England.

MRS. THOMAS'S letter in your issue of September 8 is interesting, both as affording definite proof that *Deilephila livornica* does sometimes breed in this country, and as rather tending to support the view that this species enters the country from abroad—for the proximity of Warmwell to the sea is certainly suggestive.

Apropos to rare moths, it may be of interest to state that I recently took a specimen of *Deiopeia pulchella* on the cliff here. This moth used to be so rare that Newman wrote:—"Mr. Doubleday has a single specimen taken at Epping, and we believe there are two or three other British specimens in different cabinets." Since that was written the number of English specimens has, of course, been increased, but I believe that the insect is still considered a rarity; and the scarce occurrence of a weak-flying moth like this, which one can hardly suppose could cross the Channel, and which has been found so far inland as at Epping, is a greater puzzle than the rarity, but occasional comparative abundance, of a strong-flying hawk moth.

F. H. PERRYCOSTE.

Higher Shute Cottage, Polperro, R.S.O. Cornwall, September 12.

THE HEART OF SKYE.[1]

THIS volume of detailed rock-description, raising in its successive chapters questions of profound interest in philosophic geology, proves that the Geological Survey of the United Kingdom is confident that the scientific spirit should permeate its public work. None of the rocks dealt with possesses at present an economic value; most of the area is untraversed by roads, and the exposures are not to be sought in quarries, but in rain-swept uplands, or high on desolate mountain-walls. Yet no detail is regarded as unimportant; the surveyor, for months together, leads a life as hard and remote as that of an Alaskan pioneer; and the result is a book in which the daily difficulties are concealed, while an array of facts is given to us, any one of which may help observation in other and more favoured lands.

Few lands, however, are more favoured in scenery, and the defects of Skye are mainly meteorological. The very audacity with which the black Cuillins rise from the edge of the Atlantic seems a temptation to the summer-storms. Yet the glaciated surfaces allow of small decay, and Mr. Harker directs our attention to the remarkable freshness of the rocks. Despite the absence of maps, the crystalline core of the island, with its striking scenic contrasts, long ago attracted geologists, and has been again described, in all its picturesqueness, by Sir Archibald Geikie in our own day. We well remember the seductive map, on the scale of four miles to an inch, with which we ourselves tramped across the boggy grasslands, or wandered in midnight prodigality above the Sound of Sleat; and Mr. Harker complains that, even now, names and details are not always exactly placed on the sheets issued by the Ordnance Survey. The work that he has now done, and the manner of it, will be honoured by all who know the island.

The view that the crystalline central masses represent the core of the volcano from which the abundant plateau-basalts flowed appears to be now untenable, although some kind of a volcano, and a fairly large one, may have existed on the crown of the great laccolitic dome. Certain earlier volcanic vents, moreover, provide curious evidence that gabbro and granite existed, in a consolidated form, down below, while the plateau-basalts were being extruded. In a very remarkable passage (p. 24), the author shows that even the sequence of these rocks was the same as that now known to exist in the central laccolitic area. The acid tuffs of Skye containing granite (p. 20), the basic tuffs crowded with fragments of gabbro (p. 21), go far as evidence of the continuity of lava-types with holocrystalline representatives below. It is interesting to remember that, when Prof. Judd wrote his well known papers, this natural-history view of igneous masses was very far from general acceptance; and the fact that he strove for it so successfully has been obscured by the subsequent controversy as to the local sequence in the Hebrides.

Mr. Harker, in dealing with the basalt plateaux (pp. 29, 239, and 435), shows excellently how large a part is played by the abundant intrusive sills. These form, indeed, on weathering, most of the terraced structure that observers were formerly apt to attribute to successive lava-flows. It is remarkable (p. 12) that the dykes or vents can so rarely be traced into the lava-sheets to which they gave rise; but this is a common complaint in all areas of copious and long-continued activity. The temporary theory of fissure-

[1] "The Tertiary Igneous Rocks of Skye." By Alfred Harker, M.A., F.R.S., with notes by C. T. Clough, M.A., F.G.S. Pp. xii + 482. (Memoirs of the Geological Survey of the United Kingdom. Glasgow: Printed for His Majesty's Stationery Office by James Hedderwick and Sons, 1904.) Price 9s.

eruptions has been practically modified into that of eruption from a large number of small and easily concealed vents, which were doubtless situated along fissures; and this theory is borne out by observed occurrences along rifts on Etna. Mr. Harker himself points out (p. 14) that "the great thickness and extent of the basalt group results only from the superposition and overlapping of a vast number of separate flows, each of which is of very insignificant dimensions."

The small group of trachytes and rhyolites (p. 56) in Skye occurs clearly between two series of basalts, a fact very satisfactory for Irish geologists, who have had to maintain similar views for their acid lavas on less convincing evidence. Much of the interest of the petrographic details furnished by Mr. Harker lies in the attack of one rock on another. The dissection of an early peridotite by an overpowering mass of gabbro (p. 64), the occurrence of "xenoliths" of one kind of gabbro in another (p. 121), the mutual modifications of gabbro and granite in the Red Hills (p. 183), which are justly attributed to a process of diffusion, may be named as examples of the important problems dealt with. We confess to a personal interest in the results of Mr. Harker's researches on composite sills (p. 209), where an acid rock is shown to pick up fragments of an earlier basic one, and to discharge, as it were, its own porphyritic crystals into the latter along its margins. Such facts make us doubtful of the necessity for assuming a distinction between "segregation-veins," with ill-defined edges, and "ordinary veins of intrusion" (p. 78), or for the belief that bands, the crystals of which interlock at the common surface, "must have existed side by side in the fluid state" (p. 119). The discussion of the banded gabbros, with the beautiful plates accompanying it, forms a chapter of exceptional value, though it hardly does justice to Mr. Harker's own recent work, in which he has explained the genesis of a Cainozoic banded gneiss. The reference (p. 115) of the "pyroxene-granulites" of Skye to "altered representatives of basic lavas entangled in the gabbro complex" is in happy agreement with the most modern views as to similar rock-masses in the Saxon metamorphic area.

A local rock of hybrid origin is termed *marscoite* (pp. 175 and 192); this occurs as sills, and is regarded as a basic magma modified by the absorption of granitic material prior to its intrusion. Mr. Harker holds that such "hybrid rocks are essentially abnormal in composition"; yet it may be urged that in the deeper plutonic regions many rocks, which we have come to consider normal, have arisen by processes of admixture and diffusion. The junction of the granite and the Cambrian limestone in Skye (p. 135) presents evidence of solution of the limestone, without addition of lime to the granitic magma. We prefer to believe that a slow diffusion and transference of the lime occurred into the great subterranean mass, or that the locally modified granitic magma flowed on elsewhere, leaving new and unmodified material in contact with the limestone, rather than to conclude that a rock which absorbed gabbro and Torridon Sandstone behaved in a mysteriously different manner towards dolomitic limestone. The singular absence of veins passing from the granite into the limestone rather suggests rapidity of solution. But the case is certainly an uncommon one, as other contacts of these two rocks show. Down below us as we write, an ancient granite sends off zig-zag veins abundantly into the "Dalradian" limestone of Donegal; behind us, the same granite produces a coarse quartz-diorite, by interaction with a basic sill of the same series. A little south, at Summy Lough, the pre-Devonian gabbros have brought up inclusions of an earlier gabbro, which "weather into little hollows," like those of the corrie of Tairneilear. In the universality of the problems discussed by Mr. Harker lies their wide geological attraction; and we venture to think that many of his questions will receive their answer in more distinctively plutonic regions. For a long time, Continental geologists maintained that some fundamental difference separated our modern lavas from the crystalline masses revealed in older regions of the crust. Similarly, our fluidal gneisses, with their mutual interactions, have been held to be something primordial and apart. This purely mental barrier is now rapidly breaking down, and we may find that the phenomena so carefully set before us in the case of Skye have deep-seated and more impressive representatives in the floor of Saxony or Norway.

FIG. 1.—View of Sgurr nan Gillean. (From "The Tertiary Igneous Rocks of Skye."

Mr. Harker's book, with its handsome photographic illustrations, is published at a very moderate price, seeing that it appeals entirely to the professed geologist. Indeed, when dealing with so superb an area, we think that a little more descriptive power might have been used to unite the scenic and the petrographic features. We thus wish that chapter xxvi., on "physical features and scenery," had sent off intrusive sheets into those that went before it, and had even wrapped round much of their contents as literary "xenoliths." With the manner of the text we have little fault to find. It is always clear and direct—far clearer, in fact, than the explanatory diagram on p. 433. The Americans have given us many worse names than "mugearite"; and other authors beside Mr. Harker have written "amygdule" in place of the obvious "amygdale." "Phenocryst," like "cab" and "bus," must probably be accepted as a compromise, though we expect better things of scientific men; and the incorrect use of "granophyre," introduced by Rosenbusch, has become widely tolerated through repeated publication. The term "ophitic plates," rather than "ophitic crystals"

or "ophitic nodules," where augite or hornblende are concerned, has been sanctioned by microscopists, but tends to mislead when actual rock-specimens are examined. Beyond these trifling criticisms, we have nothing but praise for this conscientious exposition of results, behind which lies a vista of personal sacrifice and prolonged observation in the field.

GRENVILLE A. J. COLE.

ENGLISH MEDICINE IN THE ANGLO-SAXON TIMES.[1]

FROM an educational point of view, an acquaintance with the history of scientific discovery is even more important than a knowledge of the results of scientific investigation up to the most recent date. The latter knowledge is essential for progress, as it is for practical application of results already gained. The former is needful in order to understand the methods of science, to imbibe the spirit of discovery, to appreciate the reciprocal action of hypothesis and experiment, and to acquire the mental habit of looking with scientific eyes upon every branch of human knowledge.

The history of mathematics, of chemistry, of geology, and of the inductive sciences in general, has been adequately treated by many foreign and by some English writers. But one of the most ancient branches of knowledge has been sadly neglected in this country. The history of medicine as the science of disease, and of medicine as the art of prevention and cure, has been far more studied by French and German, Dutch and Italian physicians than by those who write in English. It is therefore a matter of congratulation that the College of Physicians, which dates from the wonderful re-birth of learning in the days of Sir Thomas More, of Dean Colet, of Erasmus, and of Linacre, should have been entrusted by the widow of a learned member, the late Dr. Fitz-Patrick, with the endowment of a lectureship on the history of medicine.

In this volume Dr. Payne treats with remarkable learning and interest of the art of medicine as it existed among our ancestors before the Conquest. For his purpose he has not the help of such inscriptions as describe and delineate the duties of physicians in the Babylonian and the Egyptian empires, nor the rich and wonderful collection of medical instruments which is preserved in the Museum of Naples. He has only literature to depend on.

English learning dates from Archbishop Theodore of Tarsus (A.D. 669), who, with the Abbot Adrian, founded a school at Canterbury, where Greek as well as Latin, arithmetic, and astronomy was, according to the testimony of the justly Venerable Bede, successfully taught. Bede himself wrote on astronomy, and was probably the author of a treatise "De phlebotomia." In his "Ecclesiastical History of Britain" he described several epidemics of the true oriental or bubonic plague. St. John of Beverley recorded a case of aphasia in a youth who was also affected with impetigo of the scalp, and was cured of both. Among the West Saxons in the ninth and tenth centuries literature flourished. Poetry, history, and religious works were written in native English as well as in Latin, and have been adequately studied by more than one German scholar. This civilisation, with its numerous schools and libraries, was interrupted by the disastrous inroads of the Danes; but up to the Conquest and beyond, notable works appeared, and some of these were treatises on medicine. Among others published by Cockayne nearly fifty years ago were "The Leech-Book" of Bald (written when Alfred was king, or soon after his death), a book of recipes and a glossary of the names of plants, of which the manuscript is preserved in the library of the Cathedral of Durham.

The following remarks by Dr. Payne deserve to be widely read, for their application is general:—

"Before speaking in detail of the old English medical books, I will venture to say a word about the spirit in which they should be studied. Too often, those few persons who have interested themselves in these monuments of ancient science have treated them in one of two ways. Either they have picked out something especially unlike the ways of modern thought, and held it up to scorn as showing the folly of our ancestors, or else in kinder mood they have condescended to be amused, and calling anything old and unfamiliar 'quaint,' dismissed it with a smile. Neither of these methods will help us to understand the ancient world. The folly of our ancestors is no explanation. Their knowledge was no doubt extremely limited; they saw old and distant things through a dense and prevailing fog of ignorance. But that they tried to understand them at all is a proof of their wisdom, not of their folly.

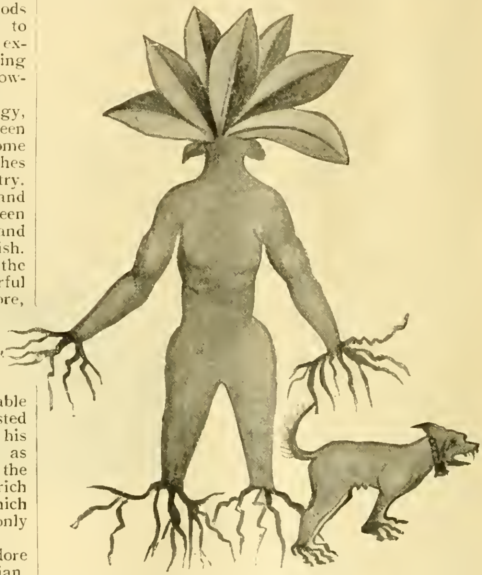

FIG. 1.—Mandragora, Mandrake, with the dog used to put it up. A simple and probably early form of the legend. (From "The Fitz-Patrick Lectures for 1903.")

"Still more misleading is the habit of regarding the rude features of primitive art, the stammering words of an infant literature, the childish fallacies of early science, as something to be amused at. Till we have got beyond the stage of calling these old things merely 'quaint,' there is no possibility of understanding them at all. Therefore, if we quote from the old books things which appear strange in our eyes, foolish things if you like, it is not with the object of raising

[1] *The Fitz-Patrick Lectures for* 1903. By Joseph Frank Payne, M.D. Oxon., Fellow and Harveian Librarian of the Royal College of Physicians, Consulting Physician to St. Thomas's Hospital. Pp. 162; with twenty-three illustrations from early English MSS. (Clarendon Press.) Price 7*s*. 6*d*. net.

a laugh or of flattering the modern sense of superiority. The only way to understand these old writers is to try to put ourselves as far as possible in their place, and conceive how nature and science presented themselves to the eyes of the early teachers and learners in the tenth and eleventh centuries."

A full account is given of the mythical "mandrake," with several instructive drawings from Anglo-Saxon manuscripts (see Fig. 1), and others of plants which can be recognised as characteristic, while some are gracefully conventional. Many drawings of foreign plants are copied from more original sketches, until they have become mere ornamental designs. These figures may be compared with the beautiful drawings published by Prof. Haeckel of animal structures adapted to suggest the decorative use of countless organic forms to carry on the conventional lines of Greek architects and Italian decorators.

An interesting section of Dr. Payne's volume is devoted to the old English names of plants. "Waybroad" has been ill exchanged for the so-called plantain, and "maythe" for camomile. On the whole, he agrees with Prof. Earle that there was a great decadence in botanical knowledge in England between the eleventh and sixteenth centuries.

The practice of surgery by the Anglo-Saxon leeches was for the most part confined to the external application of divers vegetable or animal concoctions which can have been only negatively useful. Some of them remind us of Alexis of Piedmont, who, after describing an unfailing remedy, adds, "If this will not do it, take this other." Here and there we come across curious anticipations of modern pathology and surgery, *e.g.* when we are told that if the insensible hardening of the liver is of too long duration, then it forms a dropsy which cannot be cured; or when the plastic operation for hare-lip is described. Amputation for gangrene of a limb is also recommended.

The last sixty pages are devoted to superstitious treatment by amulets and charms, some derived from Greek treatises, as they in their turn reproduced the magical lore of Egypt and of Babylon. One extract, however, from a sermon of St. Eligius, who furnished the gentle abbess of the "Canterbury Tales" with her only oath, might still be preached from English pulpits against the quackery and miscalled Christian science of the present day. If space permitted, it would be interesting to refer to Dr. Payne's comparison between the "Practica" of the famous school of Salernum and the old English "Leech-book," and to his account of the final decay of the native art of medicine and its replacement by the less vigorous and less original doctrines of Continental Europe in the later Middle Ages.

The work is of great value and interest not only to physicians, but to scholars, antiquarians, and philologists. It is admirably printed and illustrated, and will, we hope, be succeeded by the publication of future lectures by the same accomplished physician.

NOTES.

The *Atti dei Lincei* announces the death on August 19 of Prof. Emilio Villari, recently president of the Reale Accademia dei Lincei.

Mr. C. Fox-Strangways, who joined the staff of the Geological Survey in 1867, has retired from the public service.

An earthquake shock was felt in the Cowall district of Argyllshire shortly after 4 a.m. on September 18. In Dunoon the shock was most distinctly felt. Dishes rattled, doors were opened, bells were set ringing, and ornaments were broken.

Reuter reports that two distinct shocks of earthquake were felt at Ottawa at 7.53 p.m. on September 14. The first lasted five seconds, and after an intermission of three seconds came the second shock, which was of six seconds' duration. The direction was from south-west to north-east.

A congress of free thought was opened at Rome on Tuesday in the Grand Court of the Roman College. Prof. Sergi, president of the committee, welcomed the members of the congress, and the following were elected honorary presidents:—Prof. Haeckel (Germany), M. Berthelot (France), Dr. Maudsley (Great Britain), Señor Salmeron (Spain), M. Novimoff (Russia), Herr Bjoersen (Norway), and Prof. Lombroso (Italy).

At the St. Louis Exhibition a steel tower 300 feet high has been erected for wireless telegraphy by Dr. De Forest and his coadjutors, and communication has been established between St. Louis and Chicago. We learn from the *Times* that the United States Government is also exhibiting a working De Forest station, and there are seven working exhibits in the exhibition. The United States Government has contracted with the De Forest Company for five long-distance stations at Key West, Pensacola, Puertorico, South Cuba, and Panama. The longest distance between these stations will be 1000 miles, which will far exceed the distance attempted for wireless telegraphy by any Government before.

It is announced that the high-level observatory on Ben Nevis will be closed next month. The annual cost of the double observatory, high- and low-level, is close on 1000*l.*; of this sum about three-fourths is spent on the high-level and about one-fourth on the low-level station. The Treasury has offered to pay direct to the Scottish Meteorological Society on behalf of the Ben Nevis Observatory the 350*l.* recommended by the committee of inquiry into the administration of the Parliamentary grant for meteorology, instead of making this sum a charge on the meteorological grant. The continuance of the observatories could, however, only be undertaken on a guaranteed income of 1000*l.* a year. The directors have therefore decided to close the observatories.

The New York correspondent of the *Daily Chronicle* announces that Commander Peary will lead another expedition to the North Pole next year. The expedition will start in the summer, and will be gone probably not longer than two years. Its expenses are estimated at 30,000*l.*, which is 10,000*l.* more than the last Peary Expedition cost. American capitalists are supplying the funds. A vessel is now being built which, it is said, will be stronger and more suitable to the conditions prevailing in the Polar regons than any previous ship. One part of her equipment will be an ice-breaker bow, which is expected to enable the ship to break through to a point farther north than has hitherto been reached. The features of the expedition will be the fixing of a base within 500 miles of the Pole, the use of very light sledges and fast Esquimaux dogs to make a final dash for the Pole, and the adoption of conditions of living corresponding as nearly as possible to those of the Esquimaux themselves.

The expedition, on board the steamer *Frithjof*, which took out a supply of coal for the Ziegler North Polar Expedition, whose ship, the *America*, left for the Arctic regions nearly fifteen months ago, has returned to Norway without having communicated with the *America*. This is the second attempt which has been made this year by the relief expedition to reach Franz Josef Land, but on each occasion the severity of the weather, together with fog and ice, has

compelled the *Frithjof* to return; and now it is impossible that another attempt can be made until next year. There has been no news of the *America* since she left Norway in July, 1903, but, so far as can be ascertained, it was intended that on reaching Franz Josef Land the explorers should establish a supply base, from which forced marches would be made in the direction of the Pole. No apprehension is felt concerning the *America*, for the ship carried provisions for five years, and there are also stores of pemmican and clothes available.

Scientific critics in Berlin are now much exercised with regard to the remarkable performances of "Clever Hans," the thinking horse. According to the daily Press, a representative committee, which included the director of the Berlin Zoological Gardens, a veterinary surgeon, and a professor of the Physiological Institute of the Berlin University, witnessed these performances with the view of ascertaining whether they were the result of a trick, or whether they were due to the mental powers of the animal. Their verdict, it is reported, was unanimous in favour of the latter view. It is stated that when told that the day was Tuesday, and asked which day of the week this represented, the horse would give the correct answer by taps. Similarly he will tell not only the hour, but the minutes indicated by a watch; while he is also reported to be able to record the number of men and of women among a row of visitors, and to indicate the tallest and the shortest members of the party.

It is stated in the *Times* that Messrs. C. G. Spencer and Sons, of Highbury, have lately constructed, from the designs of Señor Alvares, a new aëroplane flying machine which does away with the gas vessel and its many risks. The structure consists of two swing-like aëroplanes having a superficial area of 400 square feet; these are attached to two outstretching and slightly curved arms and fixed to a bamboo framework, in shape like a cigar. In the front of this framework is fitted a 2 horse-power motor, which drives two two-bladed tractors—each of them 5 feet in diameter—which are placed one on each side of the frame, and level with the motor. At the back of the machine are three rudders, which are worked from the front by means of ropes. Two of the rudders are triangular, and are constructed to move horizontally, for the purpose of controlling the upward and downward motion of the machine, while the other, the largest of the three, which is rectangular, is fitted perpendicularly, and is intended to guide the machine to the left or right. The weight of the machine is 150 lb. without the aëronaut. It does not appear that the invention has any power of raising itself from the ground, as it is stated that during the next few days it is to be taken up by a balloon, at the Crystal Palace, to an altitude of 5000 feet, when it will be released for the purpose of testing its actual power of flight.

Sir Lowthian Bell was elected president of the Institution of Mining Engineers for the ensuing year at the meeting held at Birmingham last week. A paper by Prof. Redmayne read before the meeting is summarised on p. 524. Among other papers read was one by Mr. George Farmer, on the problem of gob-fires, in the course of which he pointed out that coal absorbs oxygen quickly, and more quickly as the surface open to oxidation increases and as the heat increases, so that any cause which will split up the gob-material will aid in initiating a fire. Moisture assists the oxidation and heating by splitting up the gob-material, so that this may be considered an important factor. In every case in which a fire has been properly located props left in the goaf, or ribs of coal left against faults, or falls in working stalls burying a rib of coal, have been found to be the origin. In any method of extinction means must be taken for cooling the hot material by the application of substances which will absorb the heat and reduce the temperature to such a degree that combustion entirely ceases in a natural atmosphere, or by the removal of the combustible material from the influence of the heat. Mr. J. Cresswell-Roscamp described an improved apparatus for laying dust in coal mines. Water (or other liquid) is forced by pumps into an air-cylinder, which causes a regular and unpulsating column to flow along the pipes and out of sprayers or nozzles fitted with a specially constructed screw apparatus round which the liquid is forced, so as to cause the spray to spread over a circular breadth up to 30 feet. The sprays are in the shape of inverted cones impinging on each other, and become broken up into extremely fine particles, which are carried along by the air current and can clearly be felt from 100 feet to 150 feet behind the apparatus when in motion.

In the year 1883 the late Sir Cuthbert Peek established an important meteorological station at Rousdon, Devon, midway between Lyme Regis and Seaton, and from time to time various self-recording instruments, including a Dines's pressure tube anemometer, have been added. The observations have been regularly continued under the superintendence of the Hon. Lady Peek, and we have received a copy of the results for the year 1903. As this volume completes a period of twenty years, tables are appended giving the average monthly and annual results for the years 1884–03. The observatory is a second order station of the Royal Meteorological Society, and the work is a valuable contribution to the climatology of the south of England.

We have received the report of the U.S. Weather Bureau for 1902–3. The first part of this elaborate compilation, containing a very interesting account of the administrative work of the year, was referred to in our issue of February 4 (vol. lxix. p. 328). The remaining portions consist of meteorological summaries, including hourly averages from the records of automatic instruments at twenty-eight stations, and monthly and annual means at stations in the United States and West Indies. Among the many valuable miscellaneous tables and reports we may mention especially those showing the accumulated amounts of precipitation for each five minutes at stations in the United States and West Indies supplied with automatic gauges, during all storms in which the rate of fall equalled 0·25 inch in five minutes or 0·75 inch in one hour. The volume also contains hourly observations at several localities in the West Indies; these are of importance in connection with the study of the destructive hurricanes which frequently occur in those regions.

It may be of interest to some of our readers to know that very complete meteorological observations, taken three times a day at the Central Meteorological Office at Vienna, together with daily and monthly means, are regularly published in the *Anzeiger* of the Vienna Academy of Sciences. Further, that the observations for each month are followed by the observations made in connection with the international scientific balloon ascents. We have before us the results of two ascents of manned and one of unmanned balloons in the month of June last. In addition to the summary of the principal facts obtained during the ascents, the actual observations taken every few minutes and explanatory remarks are given. The publication of these valuable data so soon after their occurrence is of considerable importance for the study of the processes at work in the upper strata

of the atmosphere, in connection with weather recently experienced.

THE Biological Survey of the U.S. Department of Agriculture has issued a *Circular* (No. 44) giving the names and addresses of officials connected with the preservation of birds and game in the United States and Canada.

WE have received Nos. 17 and 18 of vol. xlviii. of the *Memoirs* of the Manchester Literary and Philosophical Society. In the latter Dr. Hoyle gives a diagnostic key to the recent genera of dibranchiate cephalopods. In the former Prof. Dawkins describes a molar of the straight-tusked elephant (*Elephas antiquus*) from glacial strata at Blackpool. Apropos of fossil elephants, it may be mentioned that a few days ago workmen disentombed in a sand-pit at Erith an entire skull of a mammoth, which fell to pieces when brought to the surface. This is much to be regretted, as the specimen might doubtless have been saved had palæontologists been informed of the discovery before attempts were made to remove it from the bed.

THE August number of the *Brooklyn Edison*, published by the Edison Electric Illuminating Co., of Brooklyn, New York, contains several striking pictures of decorative and spectacular electric lighting at Coney Island, one of which, from a photograph taken at night, is here reproduced. Within a year the amount of electric illumination at this famous pleasure resort has more than trebled; and probably

FIG. 1.—Luna Park, Coney Island, showing the magnitude and extent of the electric illumination. From a photograph taken at night.

there is not now to be found anywhere in the world a place where the decorative possibilities of the electric incandescent lamp are so strikingly demonstrated. The Brooklyn Edison Co., which has successfully carried out the scheme of lighting at Coney Island, supplies light and power to an area of seventy-seven square miles and a population of nearly one and a half millions.

AN important discovery in connection with cotton-growing in the southern United States is recorded in *Bulletin* No. 49 of the Entomological Division of the U.S. Department of Agriculture. It appears that an ant has been discovered in Guatemala which preys on the adult cotton boll-weevil (*Anthonomus grandis*) and thus checks the ravages of this insect, and so permits the growing of cotton in districts where it would otherwise be impossible. It has been found that the kelep, as the ant is called in Guatemala, can be easily removed, and colonies have accordingly been introduced into the cotton plantations of Texas in the hope of checking the devastation caused by the weevil. It only remains to ascertain whether the kelep will be able to withstand the winter climate of Texas.

THE last published part of *Biometrika* contains a valuable paper by Dr. H. E. Crampton demonstrating the existence of natural selection during the pupal stage of *Philosamia cynthia*, a silk-producing moth. Dr. Crampton's observations differ from the experiments conducted by Prof. E. B. Poulton, Mr. F. Merrifield, and Miss C. Sanders in the fact that his pupæ were not exposed to the attacks of enemies; so that the elimination, which took place on a large scale, must presumably have been due to internal rather than external causes. In the author's opinion, the actual basis for selection in this particular instance is not use-advantage, but correlation. Prof. Pearson's important Huxley lecture on the inheritance of the mental and moral characters in man has been already noticed in the pages of NATURE. An elaborate memoir, illustrated by a very fine series of photographs, on the variation and correlation of the human skull, is contributed by Dr. W. R. Macdonell. The material discussed is the splendid series of skulls discovered some eleven years ago in Whitechapel, and now in the possession of Prof. Thane. Dr. Macdonell concludes that these crania, which date most probably from the time of the Great Plague, are in general appearance and biometric constants remarkably close to the Long Barrow British. As the result of an investigation on inheritance of coat-colour in the greyhound, A. Barrington, A. Lee, and K. Pearson conclude that the ancestral law of decreasing correlation holds no less for their present material than for man and horse. Prof. Weldon's research on the form of the shell spiral in a race of *Clausilia itala* failed to disclose the existence of any selective elimination between the young and the adult stage; reasons for this result are suggested. The number ends with an elementary proof of Sheppard's formulæ, with which are associated certain other formulæ for dealing with the ordinates and adjacent areas of frequency curves.

THOUGH graphical work is now rightly regarded as an essential part of an elementary course of mathematics, many teachers are still unfamiliar with the new methods, and do not comprehend clearly all that is implied in graphs. The "Solutions of the Examples in Hall's 'Graphical Algebra,'" by Mr. H. S. Hall, assisted by Mr. H. C. Beaven, just published by Messrs. Macmillan and Co., Ltd., will be of great service to those teachers and students to whom graphical methods are novel, in showing how problems may be easily and accurately solved by plotting graphs. The book will assist the introduction and extension of graphical methods in mathematical classes.

A CATALOGUE of apparatus for electric heating and cooking just issued by Messrs. Isenthal and Co., 85 Mortimer Street, London, W., contains particulars of many attractive ways in which electricity is used for heating purposes. The advantages of electric heating from a hygienic point of view are obvious; and, economically, the consumption of electric energy is not so excessive as is usually assumed. Messrs. Isenthal's list includes radiators of various types, ornamental stoves, cooking ranges and ovens, appliances for heating and boiling liquids, hot water geysers and cisterns, sterilisers, soldering bits, hot plates for chemical laboratories or photographic purposes, evaporators, and numerous other devices which would add to the comfort and cleanliness of many operations in laboratories as well as in houses. The adaptability of the electric current, and the efficiency of the various forms of apparatus described in Messrs. Isenthal's catalogue, should encourage the use of electric energy as a source of heat.

IN the August number of the *Gazzetta* E. Paternò and E. Pannain have established that, under certain conditions, electrolysis converts potassium cyanide in aqueous solution containing potash completely into cyanate. The latter separates during the electrolysis in a pure state in the form of white crystals.

ACCORDING to a brief report by J. Stěp, director of the Joachimsthal Mine, published in the *Proceedings* of the Vienna Academy of Sciences (No. 14), freshly excavated uranium ore, which has never been exposed to the light, is strongly radio-active. A comparative study of the activity of illuminated and unilluminated specimens of the ore has yet to be made.

IN vol. vii. of the *Fortschritte auf dem Gebiete der Röntgenstrahlen* Dr. Josef Rosenthal discusses the relative advantages of large and small induction coils for producing X-rays. When the tube used is not too highly exhausted, and consequently has not too great a resistance, a small coil giving a comparatively short spark may be used with good results. Small coils have, moreover, the advantage of being more portable and less costly than large coils. But when a tube with a high vacuum is used a higher tension coil has to be employed, and in such cases, in order to prevent the tube from changing during a long exposure, the number of interruptions per second must be reduced as much as possible.

OUR ASTRONOMICAL COLUMN.

THE RETURN OF ENCKE'S COMET (1904 *b*).—As announced in these columns last week, Encke's comet was re-discovered at Koenigstuhl-Heidelberg on September 11.

It was found by Herr Kopff, who describes it as being, at present, a faint object. According to a note by Mr. Denning, however, mentioned in NATURE for July 21, the favourable conditions of 1805, 1838, and 1871 should be repeated during the present apparition, and it is possible that the comet may become visible to the naked eye when near to Altair, early in December.

The accompanying chart given below shows, approximately, the apparent path of the comet among the stars from now until October 15, according to the daily ephemeris published by MM. Kaminsky and Ocoulitsch in No. 3962 of the *Astronomische Nachrichten* :—

VARIATIONS IN THE LUNAR LANDSCAPE.—A communication from Harvard reports that Prof. W. H. Pickering, at present located at the Lowe Observatory, California, observed a bright hazy object 2″ in diameter upon the floor of the lunar crater Plato on July 31. Six previous observations made between July 21–28 inclusive gave no indication of this novel feature.

On August 2 a black elliptical shadow two miles in diameter was seen in the place of the previously observed bright spot, whilst to the north-east and north there extended a large white area, the existence of which was confirmed by an observation made on August 3.

A telegram dated August 22 states that real conspicuous changes have taken place in this region during the past month, and confirms the existence of the new crater, which has a diameter of about three miles. The bright area has shifted considerably since August 3.

Several other objects which have not been mapped before were observed whilst examining Plato, and it was seen that the previously conspicuous white area surrounding craterlet No. 54 (Harvard College Observatory *Annals*, vol. xxxii., plate x.) has now disappeared.

SUN-SPOT PERIODICITY AND TERRESTRIAL PHENOMENA.—In a brochure published at Rochechouart (1904), Prof. O'Reilly, of Dublin, emphasises the important part which a knowledge of the periodicity of solar activity plays in the prediction of terrestrial meteorological events, and also demonstrates that the origins of several important historical events may possibly be attributed to the meteorological effects of solar changes.

After discussing the more recent droughts, such as have caused distress in Australia and India, and showing that these occurred at definite epochs of solar cycles, he shows that the successive floods which caused the formation of the Zuyder Zee probably occurred at epochs of sun-spot maxima. Similarly he points out that each of the ten centuries in Etruscan chronology were approximately 122·2 (*i.e.* $11 \cdot 11 \times 11$, or nearly 11^2) years in length, that is to say, they contained about eleven sun-spot periods, and he supposes that the Etruscan era probably commenced from a period of great cold, or maybe some memorable flood, which could be attributed to excessive solar activity.

From a study of Brückner's sun-spot cycles, Prof. O'Reilly believes that the year 1895 was the culminating year of a period of heat and drought, and that 1915 will be the corresponding centre-year of a period of cold and rain.

OBSERVATIONS OF THE RECENT PERSEID SHOWER.—M. Henri Perrotin, observing at Nice, saw 1184 meteors, of which 1041 were Perseids, during the nights of August 9–14 inclusive. The observations were made between the hours of 8 p.m. and 3 a.m. each night at the meteorological station of the Nice Observatory, situated at an altitude of 2740 metres on Mount Mounier.

The Perseids, as shown in his tabulated results, were very numerous, the maximum display of the shower occurring on the night of August 11–12, especially between 1 a.m. and 3 a.m. The maximum for each night occurred between midnight and 3 a.m.

A notable feature of the display was that the meteors appeared in groups of two or more, each group being followed by a break five to fifteen minutes in length.

The radiant of the shower was seen to be a fairly extensive area, not a point, having its centre near to γ Persei.

The Perseids were white and very swift, whilst the paths were comparatively short. On the other hand, the sporadic meteors observed were of a reddish-yellow colour, their paths were long, and they travelled slowly, leaving trails which lasted for some seconds.

These observations again emphasised the importance of selecting a station situated at a high altitude where the atmosphere is generally exceptionally clear (*Comptes rendus*, No. 9, 1904).

RADIATION IN THE SOLAR SYSTEM.[1]

I PROPOSE to discuss this afternoon certain effects of the energy which is continuously pouring out from the sun on all sides with the speed of light, the energy which we call sunlight when we enjoy the brilliance of a cloudless sky, which we call heat when we bask in its warmth, the stream of radiation which supports all life on our globe and is the source of all our energy.

As we all know, this ceaseless stream of energy is a form of wave motion. If we pass a beam of sunlight, or its equivalent, the beam from an electric arc, through a prism, the disturbance is analysed into a spectrum of colours, each colour of a different wave-length, the length of wave changing as we go down the spectrum from, say, 1/30,000 inch in the red to 1/80,000 of an inch in the blue or violet.

But this visible spectrum is merely the part of the stream of radiation which affects the eye. Beyond the violet are

[1] Afternoon address delivered at the Cambridge meeting of the British Association, August 23, by Prof. J. H. Poynting, F.R.S.

the still shorter waves which affect a photographic plate or a fluorescent screen, and will pass through certain substances opaque to ordinary light. Here, for instance, is a filter devised by Prof. Wood which stops visible rays, but allows the shorter invisible waves to pass and excite the fluorescence of a platinocyanide screen.

Again, beyond the red end are still longer waves, which are present in very considerable amount, and can be rendered evident by their heating effect. We can easily filter out the visible rays and still leave these long waves in the beam by passing it through a thin sheet of vulcanite. A piece of phosphorus placed at the focus of these invisible rays is at once fired, or a thermometer quickly rises in temperature. The waves which have been observed and studied up to the present time range over some nine octaves, from the long waves described to the section yesterday by Prof. Rubens, waves of which there are only 400 in an inch, down to the short waves found by Schumann in the radiation given off by hydrogen under the influence of the electric discharge, waves of which there are a quarter of a million in an inch. No doubt the range will be extended.

Radiant energy consists of a mixture of any or all of these wave-lengths, but the eye is only sensitive at the most to a little more than one octave in the nine or more.

This radiation is emitted not only by incandescent bodies such as the sun, the electric arc, or flames. All bodies are pouring out radiant energy, however hot or cold they may be. In this room we see things by the radiation which they reflect from the daylight. But besides this borrowed radiation, every surface in the room is sending out radiation of its own. Energy is pouring forth from walls, ceiling, floor, rushing about with the speed of light, striking against the opposite surfaces, and being reflected, scattered, and absorbed. And though this radiation does not affect our eyes, it is of the utmost importance in keeping us warm. Could it be stopped, we should soon be driven out by the intense cold, or remain to be frozen to death.

As the temperature of a body is raised, the stream of radiation it pours out increases in quantity. But it also changes in quality. Probably the surface always sends out waves of all lengths from the longest to the shortest, but at first when it is cold the long waves alone are appreciable. As it gets hotter, though all the waves become more intense, the shorter ones increase most in intensity, and ultimately they become so prominent that they affect our sense of sight, and then we say that the body is red or white hot.

The quality of the stream depends on the nature of the surface, some surfaces sending out more than others at the same temperature. But the stream is the greatest from a surface which is, when cold, quite black. Its blackness means that it entirely absorbs whatever radiation falls upon it, and such a surface, when heated, sends out radiation of every kind, and for a given temperature each kind of radiation is present to the full extent, that is, no surface sends out more of a given wave-length than a black surface at a given temperature.

A very simple experiment shows that a black surface is a better radiator, or pours out more energy when hot, than a surface which does not absorb fully, but reflects much of the radiation which falls upon it. If a platinum foil with some black marks on it be heated to redness, the marks, black when cold, are much brighter than the surrounding metal when hot; they are, in fact, pouring out much more visible radiation than the metal.

It is with these black surfaces that I am concerned to-day. But, inasmuch as it seems absurd to call them black when they are white hot, I prefer to call them full radiators, since they radiate more fully than any others.

For a long time past experiments have been made to seek a law connecting the radiation or energy flow from a black or fully radiating surface with its temperature. But it was only twenty-five years ago that a law was suggested by Stefan which agrees at all satisfactorily with experiment. This law is that the stream of energy is proportional to the fourth power of the temperature, reckoned from the absolute zero 273° below freezing point on the centigrade scale. This suggestion of Stefan served as the starting point of new and most fertile researches, both theoretical and practical, and we are glad to welcome to this meeting Profs. Wien, Lummer, and Rubens, who have all done most brilliant work on the subject.

Among the researches on radiation recently carried out is one by Kurlbaum in which he determined the actual amount of energy issuing from the black or fully radiating surface per second at 100° C., and therefore at any temperature.

Here is a table which gives the amount at various temperatures, as determined by Kurlbaum:—

Rate of Flow of Energy from 1 sq. cm. of Fully Radiating or "Black" Surface.

Absolute Temperature	Calories Grams of water heated 1° per sec.
0°	0·0
100° Air boils	0·000127
300° Earth's surface	0·0103
1000° Red heat	1·27
3000° Arc carbon	103
6000°	1650
6250°	1930

As an illustration of the "fourth power law," let us see what value it will give us for the temperature of the sun, assuming that he is a full radiator, or that his surface, if cooled down, would be quite black.

We can measure approximately the stream of energy which the sun is pouring out by intercepting the beam falling on a surface exposed to full sunlight, measuring the heat given to that surface per second, and then calculating what fraction the beam is of the whole stream issuing from the sun.

This was first done by Pouillet, and his method will serve to illustrate the principle of all other methods.

In his apparatus the sunlight fell full on a box containing water, and the rate at which the water rose in temperature gave the energy in the stream of solar radiation falling on the box.

Simple as the experiment appears, the determination is beset with difficulties, the chief being the estimation of the fraction of the energy intercepted by the atmosphere, and we are still unable to give a very definite value. Indeed, we cannot yet say whether the outflow of energy is constant or whether it varies. In all probability, however, it does vary, and Prof. Langley, who has devoted years of work to the subject, has recently obtained evidence indicating quite considerable variation.

We may, however, assume that we are not very far from the true value if we say that the stream of radiation from the sun falling perpendicularly on 1 sq. cm. outside the earth's atmosphere will heat 1 gm. of water 1/24° C. every second, or will give 1/24 calory per sec.

Now the area of a sphere round the sun at the distance of the earth is 46,000 times the area of the sun's surface. The energy from 1 sq. cm. of the sun thus passes through 46,000 sq. cm. at the surface of the earth. It is therefore $46,000 \times 1/24$ calories, or 1920 cal./sec. But from the table already given, a black surface at 6250° absolute, say 6000° C., gives 1930 calories per second, or the temperature of the sun's radiating surface is 6000°—if he is a full radiator, and there is good reason to suppose that no great error is made in taking him to be one.

Let us now take another illustration of the fourth power law.

Imagine a little black body which is a good conductor of heat placed in full sunlight at the distance of the earth. Let it be 1 sq. cm. in cross section, so that it is receiving 1/24 calory per second.

It will soon warm up to such a temperature that it gives out just as much as it receives, and since it is so small, heat will rapidly flow through it from side to side, so that it will all be very nearly at the same temperature. A sphere 1 sq. cm. in cross section has area 4 sq. cm., so that it must be giving out from each sq. cm. of its surface $1/96 = 0{\cdot}0104$ calory each second. From the table above it will be seen that this corresponds very nearly indeed to a temperature of 300° absolute or 27° C., say 70° F.

It is to be noted that this only applies to a little round body. A flat plate facing the sun would be about 60° C.

hotter, while if it were edgewise to the sun it might be very much colder.

Let us now see what would be the temperature of the small black sphere at other distances from the sun. It is easily seen that, inasmuch as the heat received, and therefore that given out, varies inversely as the square of the distance, the temperature, by the fourth power law, will vary inversely as the square root of the distance.

Here is a table of temperatures of small black spheres due to solar radiation :—

Distance from Sun's centre	Temperature Centigrade
$3\frac{3}{4}$ million miles	1200° C. Cast iron melts.
23 million miles	327° Lead nearly melts.
At Mercury's distance	210° Tin nearly melts.
At Venus's distance	85° Alcohol boils freely.
At Earth's distance	27° Warm summer day.
At Mars's distance	−30° Arctic cold.
At Neptune's distance	−219° Nitrogen frozen.

We see from this table that the temperature at the earth's distance is remarkably near the average temperature of the earth's surface, which is usually estimated as about 16° C. or 60° F. This can hardly be regarded as a mere coincidence. The surface of the earth receives, we know, an amount of heat from the inside almost infinitesimal compared with that which it receives from the sun, and on the sun, therefore, we depend for our temperature. The earth acquires such a temperature, in fact, that it radiates out what it receives from the sun. The earth is far too great for the distribution of heat by conduction to play any serious part in equalising the temperature of different regions. But the rotation about its axis secures nearly uniform temperature in a given latitude, and the movements of the atmosphere tend to equalise temperatures in different latitudes. Hence we should expect the earth to have, on the average, nearly the temperature of the small black body at the same distance, slightly less because it reflects some of the solar radiation, and we find that it is, in fact, some 10° less.

Prof. Wien was the first to point out that the temperature of the earth has nearly the value which we should expect from the fourth power law.

Here is a table showing the average temperatures of the surfaces of the first four planets on the supposition that they are earth-like in all their conditions :—

Table of Temperatures of Earth-like Planets.

Mercury	196° C.
Venus	79° ,,
Earth	17° ,,
Mars	−38° ,,

The most interesting case is that of Mars. He has, we know, a day nearly the same in length as ours; his axis is inclined to the ecliptic only a little more than ours, and he has some kind of atmosphere. It is exceedingly difficult to suppose, then, that his average temperature can differ much from −38° C. His atmosphere may be less protective, so that his day temperature may be higher, but then to compensate, his night temperature will be lower. Even his highest equatorial temperature cannot be much higher than the average. On certain suppositions I find that it is still 20° below the freezing point, and until some new conditions can be pointed out which enable him to establish far higher temperatures than the earth would have at the same distance, it is hard to believe that he can have polar caps of frozen water melting to liquid in his summer and filling rivers or canals. Unless he is very different from the earth, his whole surface is below the freezing point.

Let us now turn from these temperature effects of radiation to another class of effects, those due to pressure.

More than thirty years ago Clerk Maxwell showed that on his electromagnetic theory of light, light and all radiation like light should press against any surface on which it falls. There should also be a pressure back against any surface from which radiation is reflected or from which it is issuing as a source, the value in every case being equal to the energy in a cubic centimetre of the stream. The existence of this pressure was fully demonstrated independently by Lebedew and by Nichols and Hull some years ago in brilliant experiments in which they allowed a beam of light to fall on a suspended disc in a vacuum. The disc was repelled, and they measured the repulsion and found it to be about that required by Maxwell's theory. Nichols and Hull have since repeated the experiment with greater exactness, and there is now no doubt that the pressure exists and that it has Maxwell's value.

The radiation, then, poured out by the sun is not only a stream of energy. It is also, as it were, a stream of pressure pressing out the heavenly bodies on which it falls. Since the stream thins out as it diverges, according to the inverse square of the distance, the pressure on a given surface falls off according to the same law. We know the energy in a cubic centimetre of sunlight at the distance of the earth, since, moving with the velocity of light, it will supply 1/24 calory per second. It is easy to calculate that it will press with a force of 6×10^{-5} degree on a square centimetre, an amount so small that on the whole earth it is but 70,000 tons, a mere trifle compared with the three million billion tons with which the sun pulls the earth by his gravitation.

But now notice the remarkable effect of size on the relation between the radiation pressure and the gravitative pull. One is on the surface and proportional to the surface, while the other penetrates the surface and pulls every grain of matter throughout the whole volume.

Suppose we could divide the earth up into eight equal globes. Each would have half the diameter of the earth and a quarter the surface. The eight would expose twice the surface which the earth exposes, and the total radiation pressure would be doubled, while the total gravitative pull would be the same as before. Now divide up each of the eight into eight more equal globes. Again the radiation pressure would be doubled, while gravitation would be the same.

Continue the process, and it is evident that by successive division we should at last arrive at globes so small and with total surfaces so great that the pressure of the radiation would balance the pull of gravitation. Mere arithmetic shows that this balance would occur when the earth was divided up into little spheres each 1/40,000 cm. in diameter.

In other words, a little speck 1/40,000 cm., say 1/100,000 of an inch in diameter, and of density equal to that of the earth, would be neither attracted nor repelled by the sun.

This balance would hold at all distances, since both would vary in the same way with the distance. Our arithmetic comes to this: that if the earth were spread out in a thin spherical shell with radius about four times the distance of Neptune, the repulsion of sunlight falling on it would balance the inward pull by the sun, and it would have no tendency to contract.

With further division repulsion would exceed attraction, and the particles would be driven away. But I must here say that the law of repulsion does not hold down to such fine division. The repulsion is somewhat less than we have calculated owing to the diffraction of the light.

Some very suggestive speculations with regard to comets' tails have arisen from these considerations, and to these Prof. Boys directed the attention of Section A last year. We may imagine that the nucleus of a comet consists of small meteorites. When these come near the sun they are heated and explosions occur, and fine dust is produced not previously present. If the dust is sufficiently fine, radiation may overpower gravitation and drive it away from the sun, and we may have a manifestation of this expelled dust in the tail of the comet.

I do not, however, want to dwell on this to-day, but to look at the subject in another way.

Let us again introduce our small black sphere, and let us make it 1 sq. cm. in cross section, 1·13 cm. in diameter, and of the density of the earth. The gravitation pull on it is 42,000 times the radiation pressure.

Now let us see the effect of size on the radiating body. Let us halve the diameter of the sun. He would then have one-eighth the mass and one-quarter the surface. Or, while his pull was reduced to one-eighth, his radiation push would only be reduced to one-quarter. The pull would now be

only 21,000 times the push. Halve the diameter again, and the pull would be only 10,500 times the push. Reduce the diameter to 1/42,000 of its original value, that is, to about 20 miles, and the pull would equal the push.

In other words, a sun as hot as ours and 20 miles in diameter would repel bodies less than 1 cm. in diameter, and could only hold in those which were larger.

But it is, of course, absurd to think of such a small sun as this having so high a temperature as 6000°. Let us then reduce the temperature to 1/20, say 300° absolute, or the temperature of the earth. Then the radiation would be reduced to the fourth power of 1/20, or 1/160,000, and the diameter would have to be reduced to 1/160,000 of 20 miles, or about 20 cm., say 8 inches, when again radiation would balance gravitation.

It is not very difficult to show that if we had two equal spheres each of the density and temperature of the earth they would neither attract nor repel each other—their radiation pressure would balance the gravitative pull—when their diameters were about 6·8 cm., when, in fact, they were about the size of cricket balls.

It must be remembered that this is only true for spheres out in space receiving no appreciable radiation from the surrounding region.

It would appear that we have arrived at a result of some importance in considering the aggregation of small meteorites. Imagine a thinly scattered stream of small meteorites at the distance of the earth from the sun. Then, even if they be as large as cricket balls, they may have no tendency to move together. If they are smaller they may even tend to move apart and scatter.

In conclusion, let me mention one more effect of this radiation pressure. You will remember that radiation presses back against any surface from which it issues. If, then, a sphere at rest in space is radiating equally on all sides it is pressed equally on all sides, and the net result is a balance between the pressures. But suppose that it is moving. It is following up the energy which it pours forth in front, crowding it into a smaller space than if it were at rest, making it more dense. Hence the pressure is slightly greater, and it can be shown that it is greater the greater the velocity and the higher the temperature. On the other hand, it is drawing away from the energy which it pours out behind, thinning it out, as it were, and the pressure at the back is slightly less than if the sphere were at rest.

The net result is a force opposing the motion, a force like viscous friction, always tending to reduce the speed.

Thus calculation shows that there is a retarding force on the earth as it moves along its orbit amounting in all to about 20 kgm., say 50 lb. Not very serious, for in billions of years it will only reduce the velocity by 1 in a million, and it will only have serious effects if the life of the earth is prolonged at its present temperature to hundreds of billions of years.

But here again size is everything. Reduce the diameter of the moving body, and the retarding effect increases in proportion to the reduction. If the earth were reduced to the size of a marble, the effect would be appreciable in a hundred thousand years. If it were reduced to a speck of dust a thousandth of a centimetre in diameter, the effect would be appreciable in a hundred years.

Note what the effect would be. Imagine a dust particle shot out from the earth and left behind to circulate on its own account round the sun. It would be heated by the sun and would be radiating out on all sides. As it journeyed forward there would be a resisting force tending to stop it. But instead of acting in this way the resistance would enable the sun to pull the particle inwards, and the fall inwards would actually increase the velocity. This increase in the velocity would increase the resistance, and at the same time the approach to the sun would raise its temperature, increase the radiation, and so increase the resistance still further. The particle would therefore move in a more and more rapid spiral orbit, and ultimately it would fall into the sun. Small marble-sized meteorites would fall in from the distance of the earth probably in a few million years. Small particles of dust would be swept in in a few thousand years.

Thus the sun is ever at work keeping the space round him free from dust. If the particles are very minute he drives them forth into outer space. If they are larger he draws them in. It is just possible that we have evidence of this drawing in in the zodiacal light, that vast dust-like ring which stretches from the sun outwards far beyond the orbit of the earth, and is at once the largest and the most mysterious member of the solar system.

PHYSICS AT THE BRITISH ASSOCIATION.

THE number of communications made to Section A this year was again so large as to necessitate duplicate sittings on several days, an arrangement which appears to bring home to members in a forcible manner the impossibility of being in two places at once. For some undiscovered reason the subcommittee which arranges the order of the papers is generally held responsible for this limitation, and gets a considerable amount of abuse. The disadvantage of the division was particularly evident at the discussion on the units used in meteorological measurements opened by Dr. W. N. Shaw. A subcommittee of the council of the association appointed to consider the question, recommends the use of the absolute zero of temperature with either the centigrade or Fahrenheit degree as the unit, but preferably the former, and the introduction of a new "degree of pressure" which is equal to 2000 C.G.S. units, and involves a graduation of the barometer in nearly 1/16th of an inch (0·06 in.), and the use of a vernier down to 1/160 inch. The meeting before which the matter was discussed was disposed to dwell mainly on the cost of effecting the changes proposed, and owing to the scant attendance of physicists, rather lost sight of the advantages of adopting what is practically equivalent to the C.G.S. system.

Attwood's machine as an aid to the teaching of dynamics was much discredited during the discussion of a paper by Mr. Eggar on an apparatus for verifying Newton's second law. Mr. Eggar finds that the movement of a truck down an inclined plane the angle of tilt of which can be altered, is much more convenient and effective than the fall of a weight.

The coefficient of expansion of hydrogen at various pressures down to low temperatures was the subject of a communication from Prof. Witkowski. He finds that the coefficient increases with decrease of temperature, and decreases with increase of pressure, a result which must have an important bearing on our standards of temperature.

Dr. Glazebrook's account of the recent work of the National Physical Laboratory made one hope that the efforts to cope with the demands made on it by our manufacturers for tests of materials and for scientific help of other kinds, will not be hampered by the insufficiency of the financial support the institution receives from the Government. In order to establish a scale of temperature, Dr. Harker has compared up to 1000° C. the constant volume nitrogen thermometer with a thermojunction previously standardised at the Reichsanstalt, and a platinum thermometer. Mr. Smith has constructed and compared a number of mercury standards of resistance, Dr. Stanton has been engaged in determining the amount and distribution of the pressure on structures due to wind, Dr. Carpenter has investigated the solidification of iron-carbon alloys, and a number of other important investigations have been carried out for manufacturers and for the Government.

Problems connected with radiation played a prominent part in the proceedings of the section. Prof. Poynting's interesting afternoon address, which appears in another part of the present issue, dealt with the applications of the laws of radiation to the solar system. Taking Stefan's law as a basis, the temperature of the sun works out as 6250° C., and that of a black body at the distance of the earth from the sun at 27° C., which agrees well with the average temperature of the earth. A description of an apparatus by means of which he had measured the tangential stress on a surface due to the oblique impact of light, was also given to the ordinary sectional meeting by Prof. Poynting. If E is the stream of momentum per sq. cm. per second due to the light incident at an angle θ, and μ is the fraction of the incident light reflected, the tangential pressure on the surface is $(1-\mu)/2.E \sin 2\theta$, and although in general it is smaller than the normal pressure,

the difficulties of its measurement are less owing to the reduction of the disturbing effects due to the surrounding gas.

Prof. Rubens gave an account of his recent work on the optical properties of metals for long waves obtained by his method of "Reststrahlen." The radiation had about 100 times the wave-length of the sodium line, and it was found that in this region the reflecting powers of metals are independent of the wave-length. In these circumstances Maxwell's theory gives for a good conductor $1 - R = 36{\cdot}5/\sqrt{\kappa . \lambda}$, where R is the amount reflected from the surface when unit radiation is incident on it, κ is the conductivity of the metal, and λ is the wave-length. The observations on pure metals and alloys agree with the theory, and show that the electrical conductivity of a metal may now be determined by a measurement of its reflecting power.

Prof. Wien, in discussing the question as to whether the ether moves with the earth or not, pointed out that according to the recent work of Lorentz, in which the electron is assumed to be ellipsoidal in form, attempts to settle the question based on interference or the rotation of the plane of polarisation would be without result. He thought himself the most promising method was a duplication of Foucault's revolving mirror method, the reflection taking place at the two ends from mirrors revolving with the same velocity. If the ether has a component movement along the line joining the mirrors the deflections observed at the two ends should differ.

Prof. Kayser directed attention to the defects of Rowland's scale of wave-lengths in view of the accuracy now attainable by interference methods of measuring wave-lengths. He considered that concave grating spectra were only suitable for interpolation purposes, and that the preparation of a standard scale should be taken in hand at once. Mr. Newall suggested that dark lines were more suitable than bright ones for this purpose.

Dr. Lummer, in describing his parallel plate spectroscope for the resolution of close spectral lines, pointed out the importance of high resolution if the effects of the mode of excitation or of an electrostatic field on the lines of a gas are to be investigated. Dr. Lummer showed his instrument in use in the Cavendish Laboratory, and was able to detect a difference between the lines of mercury, sodium, hydrogen, and helium when produced by Hertzian waves and when produced by the induction coil spark.

In connection with the preparation of the plates of the spectroscope, Lord Rayleigh mentioned that he had found the use of dilute hydrofluoric acid very effective in putting on the finishing touches to glass surfaces.

Prof. Wood described the interference method he had used to determine the dispersion of sodium vapour. The vapour was produced in an exhausted tube with plane ends surrounded by a wire by which the tube was electrically heated. Over a range extending to $\lambda^2/(\lambda^2 - \lambda_m^2) = 3900$ the results agree well with the formula $n^2 = 1 + m\,\lambda^2/(\lambda^2 - \lambda_m^2)$.

The discussion on "n-rays" was very one sided, as no one who spoke had succeeded in convincing himself that any effects he may have observed were not subjective.

Throughout the whole of the meeting communications dealing with radio-activity attracted a large amount of attention. Lord Kelvin described his models of radium atoms to give out α and β rays respectively. The former consisted of an "electrion" e placed at the point of contact of two spheres, through the volumes of which charges $-4e$ are uniformly distributed. When equilibrium is destroyed and the spheres move apart the electrion accompanies one sphere and we have the α particle. In the same way if two electrions e are in equilibrium at opposite extremities of a diameter of a sphere through the volume of which a charge $-\frac{1}{4}e$ is uniformly distributed, and equilibrium is destroyed, one of the electrions moves away from the sphere and gives the β ray.

Prof. Schuster described his apparatus in which radium is utilised in measuring the rate of production of ions in the atmosphere. Changes in the state of the atmosphere are found to take place much more rapidly than was anticipated, so that it is not advisable to use any method of measurement which involves the constancy of the state for more than five minutes.

Prof. Thomson gave an account of the work which has been done recently at the Cavendish Laboratory to determine whether ordinary matter possesses to a small extent the property of radio-activity so strongly shown by radium and polonium. His criterion for the possession of this property is that the substance shall be capable of producing electrical conductivity in the gas in a closed vessel in its neighbourhood. The difficulties of the investigation are due to the wide distribution of radium in soil, water, and air, and to the fact that the emanation from it settles on bodies left exposed to the air. A small quantity of radio-active material present in the body from either of these causes may be sufficient to mask the effect due to the substance itself.

From his observations Prof. Thomson concludes that each metal gives out a specific radiation which differs in its properties from the radiation sent out by other substances, and appears not to be a secondary radiation due to the impact on the substance of some form of penetrating radiation present in the atmosphere. The search for a radio-active gas produced by each metal has so far proved unsuccessful, but Prof. Thomson thinks there is some indirect evidence for the existence of such a gas.

Dr. Elster and Dr. Geitel pointed out that any results obtained by the use of the conducting property of a gas were open to the objection that the effects observed might still be due to traces of radio-active matter left in the apparatus, and not to the metals themselves.

Prof. Thomson's description of his work was necessarily much condensed, and physicists will look forward to the publication of a more complete account which will set aside this objection.

On the last morning of the meeting Prof. Fleming exhibited his apparatus for measuring the lengths of Hertzian waves such as are used in wireless telegraphy. A wire helix has attached to one end a metal plate which, with a similar plate attached to the apparatus in which the electrical oscillations originate, forms a condenser. The effective length of the helix is altered by a sliding conducting saddle, and the positions of the antinodes along the helix are determined by a Neon vacuum tube held perpendicular to the axis of the helix. From the dimensions of the helix the velocity of the waves along it can be calculated, and hence the frequency of the oscillation and its wave-length in air. Prof. Rubens stated that a similar method had been in use in Berlin for some time in connection with a portable apparatus for measuring the lengths of the waves used in the Slaby system of wireless telegraphy.

From the above notes of some of the matters brought forward it will be evident that the Cambridge meeting will hold its own as one of the most interesting of recent years.

C. H. LEES.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE proceedings of Section B (chemistry) were characterised not only by the general interest attaching to the numerous papers presented, but also by the unusually large attendances at the meetings, and chiefly by the presence of more than twenty distinguished Continental chemists, who made several important contributions to the business of the section.

The foreign visitors included Prof. Aschan (Helsingfors), Prof. Brühl (Heidelberg), Prof. Max Busch (Erlangen), Prof. Dieterici (Hanover), Dr. Etard (Paris), Prof. Franchimont (Leyden), Prof. M. Freund (Frankfurt), Prof. Gabriel (Berlin), M. le Comte de Gramont (Paris), Prof. Groth (Munich), Prof. Guye (Geneva), Prof. Haller (Paris), Prof. Kayser (Bonn), Prof. Knoevenagel (Heidelberg), Prof. Leduc (Paris), Prof. Richard Meyer (Brunswick), Dr. E. Noelting (Mülhausen), Prof. van Romburgh (Utrecht), Dr. Rupe (Bâle), Prof. I. Traube (Berlin), Prof. Walden (Riga), Prof. Wedekind (Tübingen), Prof. Wegscheider (Vienna), Prof. Wien (Würzburg), and Prof. Wolffenstein (Berlin).

The following papers were read:—On the bearing of the colour phenomena presented by radium compounds: W. Ackroyd. On the pentavalent nitrogen atom: Prof. O. Aschan. Saponarin, a glucoside coloured blue by iodine: Dr. G. Barger. The relation between the crystalline and the amorphous states as disclosed by the surface flow of solids: G. T. Beilby. The action of certain gases on glass in the neighbourhood of hot metals: G. T. Beilby. The change of conductivity in solutions during chemical re-

actions: P. V. Bevan. The union of hydrogen and oxygen in contact with a hot surface: Dr. W. A. Bone and R. V. Wheeler. On the formation of salts in solution, especially in tautomeric bodies: Prof. J. W. Brühl. On the active variety of chlorine: D. L. Chapman and C. H. Burgess. Hydroaromatic compounds: Prof. A. W. Crossley. On the energy of water and steam at high temperatures: Prof. C. Dieterici. A suggested explanation of the phenomena of opalescence observed in the neighbourhood of critical states: Prof. F. G. Donnan. On double acetylides: Major A. E. Edwards and Prof. W. R. E. Hodgkinson. Sur les manganates et les permanganates: Dr. A. Etard. Mesoxalic semialdehyde: H. J. H. Fenton. Note on the influence of radium radiations on atmospheric oxidation in presence of iron: H. J. H. Fenton. A reaction for ketoses: H. J. H. Fenton. A colour reaction for methylfurfural and its derivatives: H. J. H. Fenton and J. P. Millington. Ueber Isocystein (Isothioserin): Prof. S. Gabriel. Sur le spectre du souffre dans la photographie de l'étincelle des minéraux: M. le Comte de Gramont. Quelques observations sur le groupement des raies du spectre du silicium d'après l'effet de la self-induction, et sur leur présence dans les spectres stellaires: M. le Comte de Gramont. On crystal structure and its relations to chemical constitution: Prof. P. Groth. Methods of investigating alloys illustrated from the copper-tin series: C. T. Heycock and F. H. Neville. On some reactions between ammonium salts and metals: Prof. W. R. E. Hodgkinson and A. H. Coote. The stereochemistry of nitrogen: Dr. H. O. Jones. The constitution of nickel carbonyl: Dr. H. O. Jones. Exhibition of photographs of sections of an Australian siderite: Prof. A. Liversidge. On dynamic isomerism: Dr. T. M. Lowry. The oxidation of carbohydrates by hydrogen peroxide in presence of ferrous sulphate: R. S. Morrell and A. E. Bellars. Studies in the dynamic isomerism of α- and β-crotonic acids: R. S. Morrell and E. K. Hanson. The constitution of phthalein salts: Prof. Richard Meyer. The decomposition and synthesis of ammonia: Dr. E. P. Perman. Changes produced by the β rays: Sir William Ramsay. The action of organic bases on olefinic ketonic compounds: Dr. S. Ruhemann. (1) The vapour density of hydrazine hydrate; (2) the combining volumes of carbon monoxide and oxygen; (3) the action of heat on oxalates; (4) some alkyl derivatives of sulphur, selenium, and tellurion: Dr. A. Scott. A hexachlor-α-picoline and its derivatives: W. J. Sell. A new theory of the periodic law: G. J. Stokes. On the presence of arsenic in the body and its secretion by the kidneys: W. Thomson. On the velocity of osmosis and on solubility; a contribution to the theory of narcosis: Prof. Isidor Traube. Exhibition of effects produced by precipitating silver chromate in gelatin: Prof. Isidor Traube. The asymmetric nitrogen atom: Prof. E. Wedekind. On the products obtained by the action of tertiary bases on some acid chlorides: Prof. E. Wedekind. Pseudomorphosis in organic persulphates: Prof. R. Wolffenstein.

As in previous years, the practice of inviting two special reports on subjects of current interest and making these the basis of a discussion, met with considerable success, the communications of this order at the Cambridge meeting being made by Dr. H. O. Jones and Dr. T. M. Lowry; forming comprehensive summaries of our knowledge of the subjects discussed, which will be found very valuable by all who are engaged in teaching chemistry. The business of the section was brought to a conclusion on Tuesday afternoon by an address from Sir James Dewar on new low temperature phenomena and their scientific applications; this attracted a very large and appreciative audience, who followed the novel experiments with the greatest interest. The committees of the previous year were re-appointed, and two new committees were formed to deal with the subjects of dynamic isomerism and transformation of diazonium compounds and allied substances.

Although the neighbourhood of Cambridge does not offer many opportunities for studying industries of chemical interest, a very successful visit was made to the woad works near Wisbech, a description of which has appeared already in the columns of NATURE. Visitors were shown the processes of cropping, milling, and balling, and examined the drying racks on which the balls are placed until the second milling process, which takes place in November.

GEOLOGY AT THE BRITISH ASSOCIATION.

FOLLOWING the president's address, which has already appeared in these pages, Dr. Marr gave an address on the geology of Cambridgeshire. He described the main physical features of the county, and showed their relations to geological structure. Opportunities were afforded during the meeting, by afternoon excursions, for visiting most of the typical sections of Jurassic and Cretaceous rocks exposed near Cambridge, including the interesting occurrence of Upper Gault at Barnwell, in which Mr. Fearnsides recently discovered an unsuspected fauna. The Boulder-clays and gravels which cover a large portion of the surface of Cambridgeshire were dealt with by Dr. Marr in his address, and were further described by Messrs. Fearnsides and Rastall, who gave an account of the boulders collected by the members of the Sedgwick Club. Mr. F. W. Harmer, in a comprehensive paper on the Great Eastern Glacier, showed that its product, the Chalky Boulder-clay, extending over a great part of the eastern counties, has a palmate form, its lobes radiating from the great depression of the Lincolnshire and Cambridgeshire fens. The fens were the centre whence the Chalky Boulder-clay was distributed, and formed the quarry out of which was excavated the enormous mass of Jurassic material which forms the matrix of this deposit.

Much of the Boulder-clay about Leicester, in his opinion, was due to the ice stream of the Trent Valley having been piled up, upon the high lands to the east of Leicester, by the pressure of ice descending from the Pennine Chain. He found no evidence to show that any considerable amount of ice entered East Anglia through the Wash gap.

Mr. W. Whitaker showed that in the valley of the Stour deep channels filled with drift have been proved by borings, one of them having a depth of no less than 477 feet. How these channels extending below sea level have been excavated is a moot point, and in this connection Mr. Lamplugh pointed out that Dr. Gilbert has found in Alaska that the excavating power of ice debouching on the sea is carried on below sea level, and until the depth of water is sufficient to float the ice.

In a note on a small anticline in the Great Oolite series at Clapham, north of Bedford, Mr. H. B. Woodward directed attention to a small fold trending N.N.W. to S.S.E. Its direction is contrary to the minor undulations affecting the Oolitic strata of the district, and while there is no evidence to connect the disturbance with glacial action, there is equally no evidence against such a supposition.

Mr. John Spiller gave an account of the recent coast erosion in Suffolk, between Dunwich and Covehithe. At Easton losses of 39 feet and 55 feet have occurred at different points during the past two years.

A report on the fossiliferous drift deposits at Kirmington was read by Mr. J. W. Stather. A boring conducted by a committee appointed by the association proved solid chalk to exist at a depth of 93 feet, and above this were two boulder-clays separated by a bed of shingle and 18½ feet of laminated warp with estuarine shells. Thin peat and sand containing fresh-water shells were found at the base of the warp. The plants in the peat, according to Mr. Clement Reid, indicate estuarine conditions, and suggest a subarctic climate. Another boring at Great Limber showed a similar laminated warp, but without shells, and it does not rest on Glacial clays.

Mr. Edward Greenly, in describing the glaciation of Holyhead Mountain, showed that the northern and eastern slopes are strongly rubbed and rounded in a general N.E. to S.W. direction, and striæ occur on the summit 721 feet above sea level, parallel with the trend of the general glaciation of Anglesey. Mica schists, occurring *in situ* at a level of 200 to 300 feet, have been raised 500 feet above their source. He ascribes the phenomena to the action of land ice, and some ill-defined moraines composed of local débris he thinks may be due to small local glaciers.

Prof. P. F. Kendall presented a report of the committee on erratic blocks, and later exhibited a model of the Cleveland area showing glacier-lakes. He incidentally referred to a boulder of Red Crag of the Waltonian type found near Sherringham on the occasion of the association excursion to Cromer. The Rev. W. L. Carter, in describing the

glaciation of the Don and Dearne Valleys, sought to extend the system of glacier lakes and overflows of the Cleveland area further south, and in another paper dealing with river capture in the Don system he explained the present condition of the Don and its tributaries as resulting from a series of river captures due to the deep cutting of its valley by the Sheaf, and its predominant power in capturing consequent streams north and south.

Other papers dealing with Glacial and post-Glacial geology were read by the Rev. Dr. A. Irving, on stratified high-level gravels and their relation to the Boulder-clay; by Mr. A. W. Gibb, on the occurrence of pebbles of white chalk in Aberdeenshire Clay; the Rev. O. Fisher, on an elephant trench at Dewlish, Dorset; Mr. H. N. Davies, on the discovery of human remains under Stalagmite in Gough's Cave, Cheddar; and reports of committees were read on Irish caves, tidal action in the River Mersey, and underground waters of north-west Yorkshire.

On the day devoted to palæontology, Prof. Sollas gave an account of his new method of examining fossils by means of serial sections and their reconstruction by means of wax models. In this way he contrasted the structure of Ophiurids of recent and fossil types.

The finding of Holoptychius scales in the Cornstones of Salisbury Crag has led Drs. Horne and Peach to regard some of the beds occurring near Edinburgh, and hitherto thought to be of Carboniferous age, as belonging to the Old Red Sandstone period. Dr. Horne described the beds, and exhibited a revised map of the district. Dr. Traquair dealt with the fish remains found in the above deposits, and then read a paper on the fauna of the Upper Old Red Sandstone of the Moray Firth area, in which he summarised the results of many years' work.

Mr. G. W. Lamplugh directed attention to the fact that many of the phosphatic casts of fossils found in the Lower Cretaceous rocks at Upware, Potton, and Brickhill, and usually regarded as derivative, really are indigenous. At Speeton and in Lincolnshire these same fossils are found at their proper horizons, and indicate the life of the period. In another paper Mr. Lamplugh showed, by means of the marine fossils from the Ironstones of Shotover Hill, that the Ironstone originated through the alteration of a band of Portland Limestone.

Mr. E. A. Newell Arber, discussing the fossil plants of the Upper Culm Measures of Devon, concludes that the flora indicates an Upper Carboniferous age, and the coal-bearing beds of the Bideford district are the equivalents of the Middle Coal-measures elsewhere in Britain—a higher horizon than has previously been assigned to these beds.

In the same measures, too, he has found mineralised plant remains in the form of rolled fragments of stems, arranged without order in a fine grained sandstone. These are not contemporaneous with the sandstone.

The committee on the life zones in the British Carboniferous rocks reported investigations made in the Culm Measures of North Devon, the Pendleside series of the Derwent Valley, Derbyshire, the North Staffordshire Coalfield, and in South Wales.

The second report of the committee on the fauna and flora of the Trias included an elaborate description of rhyncosauroid and chelonoid footprints, beautifully illustrated by photographs by Mr. H. C. Beasley, and lists of Triassic fossils in the Jermyn Street and British Museums by Mr. E. T. Newton and Dr. A. Smith Woodward.

Prof. H. G. Seeley exhibited and described fossil footprints of reptiles from the Stormberg beds of the Karroo of Cape Colony.

In petrology and mineralogy eight papers were read. One, by Prof. H. Bäckström, was of great interest as showing that the great iron ore deposits of Lappland have been brought up by volcanic agency from great depths.

Mr. A. Harker exhibited a series of Tertiary Plutonic rocks (including gneisses) from the Isle of Rum. He described the characters and distribution of the earlier ultrabasic group. Into these eucrite has been intruded, and later an acid magma. The complex was then streaked out by movement, and well banded gneisses of the Lewisian type were formed.

Mr. E. Greenly suggested that the recent lava-pyramid formed on Mont Pelée might afford a clue to the origin of the lava domes of the Eifel.

Prof. H. A. Miers, dealing with the occurrence of gold in pyrites crystals, showed that in the Urals fresh crystals contained the gold uniformly disseminated, whereas on weathering into limonite the gold formed a nugget in the middle with crystalline facets. As other examples of concentration due to the attractive forces of crystallisation, he cited gypsum in clay, marcasite, pyrites, barytes, and phosphatic nodules.

Mr. Lamplugh, in the discussion which followed, remarked that the "dead earth is alive all the time," and gave instances where the formation of nodules has crushed the surrounding shales.

The basic patches occurring in the Mount Sorrel Granite, according to Mr. R. H. Rastall, are all inclusions of foreign material, and are not the result of concretionary action.

Papers were also read on the different modifications of zircon by Mr. L. J. Spencer, and on three new minerals and curious crystals of blende from the Binnenthal by Mr. R. H. Solly.

The granite from Gready in Cornwall was described by Prof. K. Busz.

The geology of the Oban Hills, Southern Nigeria, by Mr. J. Parkinson, and the report of the committee on geological photographs, complete the list of papers read in Section C, with the exception of a paper by Prof. Kendall on evidence in the Secondary rocks of persistent movement in the Charnian Range, and the discussion on the nature and origin of earth movements, an account of which is subjoined.

Discussion on the Nature and Origin of Earth Movements.

The president, in introducing the subject, which proved to be one of the most attractive features of the section, observed that movements of the earth's crust manifesting themselves in the fracturing, overthrusting, and folding of strata had been in operation from the earliest to the latest geological periods, and though intermittent so far as any one region was concerned, there was reason to believe that they had been more or less continuously in action throughout the world as a whole. Their operations, in fact, were essential to the existence of land surfaces, for in their absence all rocks projecting above the sea would be worn away, and the globe would be enveloped in one continuous ocean. Notwithstanding these facts, no theory as to the cause of the movements has commanded universal acceptance.

While some hold that the shrinking of the globe by cooling and the efforts of the crust to adapt itself to the shrinking interior are the prime causes, others maintain that the scale on which folding and overthrusting in the crust have taken place is out of all proportion to the shrinking that can be attributed to such a cause.

Earth movements may be divided into two principal classes, namely, movements of expansion, which are evidenced by normal faulting, and movements of compression, such as are indicated by buckling, overthrusting, and shearing of strata, by the superinduced structures of cleavage and schistosity, and by the extrusion of granitic rocks and metamorphism.

Dr. Horne presented the evidence he had accumulated from observations in the north-west Highlands, and traced the types of movement from the unaltered areas to the areas showing the greatest disturbance of all, namely, the Moine schists. In one region the Moine schists have been pushed ten miles to the west, and are seen lying on undisturbed Cambrian Limestone. Some of the movements undoubtedly occurred in pre-Torridonian times, others succeeded almost up to the Devonian period.

The veteran geologist, the Rev. Osmond Fisher, said he used to think that the corrugations of the earth's crust were due to compression through the shrinking of the interior. To judge of the sufficiency of this cause, the first thing to be done was to seek a measure of the compression, and then compare the result of the effects of cooling with the actual amount of compression. The most satisfactory measure appeared to be the thickness of the layer which the corrugations would form if levelled down. In 1863 Lord Kelvin formulated a law of secular cooling upon the hypothesis of a solid interior. Adopting a probable value for the contraction of rocks in cooling, Mr. Fisher calculated

the thickness of the layer which would be produced by the corrugations resulting, and found it far short of that which the existing inequalities would form if levelled down. The discovery of a level of no strain within the crust by Mr. Mellard Reade and Dr. Davison further reduced the possible amount of corrugation. Even a substratum of liquid magma holding water gas in solution would not account for it, and he therefore argued that the substratum was affected by convection currents, which, ascending beneath the oceans, flowed horizontally towards and beneath the continents.

Mr. J. J. H. Teall discussed the petrological aspect of the general question, and divided the effects of movements upon rocks into two classes, easily separable, namely, local and regional. The former were confined to the immediate areas of dislocation, while the latter extended over tens or hundreds of square miles.

Local movements were characterised by fault breccias and mylonites, these being close grained, compact rocks formed by the crushing down of original rocks as in a mill. In some cases there was no crushing, the dykes being converted into foliated schists. In respect of regional effects, we have slaty cleavage due to mechanical deformation of extensive tracts of country. Foliation might be due to the original form of crystallisation or to earth movements after consolidation.

Prof. T. McKenny Hughes thought that lateral pressure, not necessarily horizontal, had produced almost every feature, and that faults were due to compression occasioned by such pressure rather than by extension.

The folding skin of an apple due to shrinkage of the interior was not wholly comparable to earth folding, for, in the case of the earth, many complex circumstances had to be taken into account. Time was one important point, as well as such forces as molecular deformation, temperature changes, volume and force of crystallisation, and transference of material from one region to another.

Prof. W. J. Sollas said that the belts of folding could usually be correlated with the margins of preexisting oceans, and those belts of folding which were comparatively superficial must be accounted for by deep-seated causes. The inequality of the present earth was the best guide to former folding. Inequality at the meeting places of oceans and continents, together with sedimentary deposits on the ocean floor, altered the isothermal lines—flattening them out—and so produced stresses and thrusts, which resulted in pushing part of the material seawards. Thus there was a redistribution of pressure, and this produced fluid magmas, with earthquakes and volcanoes resulting. He thought that all this, however, would hardly suffice for the results produced. There must be another cause. The earth was more pear-shaped in the past than it now is by reason of its relation to the moon. Constant deformation towards its present shape produced contraction of the two hemispheres, and thus the American and Australian beltings or folds were, he thought, accounted for. Deformation of this character produced the same effects as contraction, and the two causes together, he considered, might be enough to account for the existing phenomena produced by earth movements.

Sir John Evans remarked that thirty years ago he had argued that if a globe with a fluid nucleus and a solid crust were postulated, deposition or other causes would result in the solid crust moving over the nucleus, and this disturbance would produce a change in the position of the pole. There was evidence of such a change in the fossil fauna and flora of the Arctic and Antarctic regions. This might be an additional aid beyond those due to cooling.

Prof. Blake thought that, in speaking of thrusts, Dr. Horne had only given the description, and not the cause. In the north of Scotland, where did the force come from? He suggested that if mountains expanded upwards by lateral or upward pressure, a sufficient cause for such thrusts would be found. He had never, he said, seen a true isoclinal fold, and he considered it mathematically impossible for one to exist; the nearest to it in nature was a pleisioclinal fold.

Prof. Rothpletz, of Munich, referred to overthrusts he had observed in Saxony twenty-five years ago. The Scotch overthrusts were older than those of the Alps. In the Alps the plane of the overthrust got steeper and steeper as it approached Vienna. When the folding was a shortening of the earth's crust, the overthrust was a shortening too, in another direction. The matter was more difficult of observation in Scotland, as the overthrusts ended in the sea.

Prof. Boyd Dawkins referred to a case in the Derwent Valley where folding had taken place over level beds, and thought they were not necessarily formed at the root below mountains.

Prof. J. Milne submitted that the seismologist required a world like that of the physicist, one as rigid as cast iron. Earthquake waves traverse chords of the earth at 11 or 12 km. a second, *i.e.* twice as rapid as through steel. This indicates a world very rigid and uniform in the interior. He thought that if it were liquid with convection currents, as urged by Mr. Fisher, the velocity of tremors would not be uniform.

Dr. Knott advised caution in accepting the abrupt change from solid to liquid as supposed by Prof. Sollas. The changes from solid to liquid would probably be through a viscous condition.

Prof. Kendall, in winding up the discussion, pointed out that the special feature of continental margins was deposition. Deposits, acting as imperfectly conducting blankets, would cause the isotherms and the critical zone to rise, and the weakest spot would give way. Given stiff rocks above the critical zone and plastic rocks below, puckering must take place. He considered that in thrust planes the rocks were not forced over horsts, but the horst was wedged underneath them. While areas of sedimentation were weak, other and thinner rocks were stationary under deforming stresses.

Following the discussion, Prof. Kendall read a paper on the evidence in the Secondary rocks of persistent movement in the Charnian Range, in which he gave specific examples of the movements which had been discussed by previous speakers. He referred to the speculations of Godwin Austen, who stated that all recent anticlines are built on older anticlines.

The Charnwood rocks showed evidence of folding in a N.E. to S.W. direction even before Cambrian times. These movements were continued in pre-Carboniferous, Carboniferous, and Permian times, and grounds existed for the belief that they were repeated at intervals during the Jurassic and Cretaceous periods. The Charnian axis, he believes, constitutes the boundary of two important coal fields which extend under the Secondary rocks far to the south.

J. LOMAS.

RECENT STUDIES OF DISEASE ORGANISMS.

AT the recent Cambridge meeting of the British Association, the results of several investigations of organisms associated with various diseases were described before the section of zoology, and are here summarised separately from the general report of the proceedings of the section, which will appear in another issue of NATURE.

Mr. A. E. Shipley, F.R.S., on behalf of Dr. Elliot Smith, gave a brief account of Looss's observations on *Ankylostoma duodenale* (miner's worm), and directed attention to the series of preparations sent by Prof. Looss from Cairo illustrative of his recent work. The male and female of this worm are found hanging in numbers to the intestinal walls of the man affected, and produce enormous numbers of eggs, which are discharged from the body. These give rise to small active worm-like larvæ which live in mud, and enter the body of man either along with food or through the skin, which they can penetrate without causing any visible lesion of the part. They then enter the lymph- and blood-vessels, are swept into the circulation, and eventually reach the lungs, where they pass from the blood-vessels into the air cavities. From the time the larvæ perforate the skin until they reach the lungs they remain the same size, but as soon as they reach the air vesicle they begin to grow rapidly. They pass into the bronchioles, up the bronchi and trachea, and, emerging through the glottis, pass down the œsophagus to the duodenum, where they become sexually mature. The bare-footed races of the tropics and subtropics, both in the Old World and America, are widely and generally infected with this worm, which produces severe anæmia, often ending in the death of the host.

Mr. G. P. Bidder pointed out the great economic importance of Looss's researches. He stated that experts now believed the majority of cases in the Cornish tin mines were due to infection of the bare shoulders, arms and hands, through coming into contact with some polluted surface in the mine. Against such infection, cleanliness in feeding, which has been recommended as the principal precaution, is of no avail. The question is a serious one, as the disease is grave, and there are half a million men working in our coal mines. Though as many as 80 per cent. of the men were affected in some Continental mines, the disease does not at present exist in British collieries; but in many of these there are those conditions of temperature and humidity which would be favourable to its propagation.

Prof. Simmers (Cairo) commented on the paper from an experience of thousands of cases. Nothing resembling the "miners' bunches" which have been described as occurring in Cornwall has been met with in Cairo. Looss's experiments on puppies point to a definite toxic effect on the tissues penetrated by the larvæ. A remarkable feature about the adult parasite is the absence of any wounds or bleeding on the intestinal wall to which it adheres. The muscular mouth of the worm appears to draw up the tissues into a sort of bell, and at the same time to secrete into the blood some substance which has the power of breaking up the constituents of the blood, so causing the peculiar anæmia.

Prof. G. N. Calkins gave to the section an account of his work on *Cytoryctes variolae*, Guarnieri, the organism of small-pox. After the inoculation of a rabbit's cornea with vaccine virus, Guarnieri (1892) found in the cells peculiar homogeneous structures of diverse form and size, and regarded them as Protozoa. Pathologists, however, do not accept this conclusion, as the "Guarnieri bodies" have no apparent structure, and cannot be cultivated on artificial media. Prof. Calkins considered these objections were dispelled by the experiments of Wasielewsky (1901), who vaccinated a rabbit with a small quantity of virus; from this a second rabbit was vaccinated, from the latter a third, and so on until forty-seven had been successfully inoculated. In all the rabbits the "Guarnieri bodies" were found, and Prof. Calkins believes they had undergone growth and multiplication—the attributes of a living organism. In 1902 Councilman discovered, in addition to the usual bodies in the cytoplasm, peculiar and definite bodies in the nuclei of skin-cells infected with small-pox. Prof. Calkins has worked over this material (from fifty-five cases), and has formulated a life-history. The first appearance of the organism in the human skin is a minute homogeneous spherule which enlarges and differentiates into two substances, one destined to give rise to the multiplication elements, the other forming an enveloping matrix. The organism increases in size until it is larger than the cell nucleus. The gemmules repeat the cycle again and again, thus giving rise to auto-infection of the vaccinia type. In later stages the gemmules enter the nucleus, where they develop into two kinds of structures, possibly male and female gametocytes. From the latter a sporoblast stage arises, the sporoblasts increase in size, and ultimately give rise to spores. Meantime, the nuclear membrane has been ruptured and the sporoblasts liberated. The spores are hollow spherules $0{\cdot}5\mu$ in diameter. Spores may be found scattered in the cytoplasm and in the nucleus, but it is only in the latter that they can develop further.

After Mr. J. J. Lister, F.R.S., had commented on the apparent absence of a definite nucleus, Dr. S. Monckton Copeman, F.R.S., mentioned that in a paper by Dr. Gustav Mann and himself (1898–9) practically all the features described by Prof. Calkins are shown, but that their interpretations are entirely different. They regarded the "Guarnieri bodies" as masses of nucleo-proteid material which have been extruded into the perinuclear space as the result of specific irritation, and it is noteworthy that these bodies are all found, in cases of inoculated variola or vaccinia, on the side of the nucleus *remote* from the point of inoculation, whereas the reverse might be expected if they were Protozoa. Similar appearances have been described by Pfeiffer and others in carcinoma, sarcoma, chicken-pox, and various vesicular skin diseases, all of which diseases cannot be due to the same specific agent. The specific zymotic disease which in all respects—period of inoculation, progress, affection of the skin and mucous membranes, production of immunity, &c.—most closely resembles small-pox, viz. enteric or typhoid fever, is now acknowledged to be a bacillary disease, and there would seem to be reason for believing small-pox to be due to an invasion of the system by a similar organism. Dr. Copeman considers that the small bacillus, which he demonstrated at the Liverpool meeting, which stains with great difficulty and cannot be grown on any of the ordinary laboratory media, represents the specific virus of small-pox and vaccinia.

Dr. J. A. Murray, of the Imperial Cancer Research Fund, read to the section a paper on the biological significance of certain aspects of the general pathology of cancer. He stated that both benign and malignant new growths increase their characteristic parenchyma entirely from their own resources, and there is no evidence of the transformation of the original tissue into malignant tissue, although the latter may be indistinguishable histologically from that among which it takes its origin. The cells increase by division; amitosis does occur, but mitotic division is much more common in fully developed tumours. Multipolar mitoses are common. The active growth and extension of the malignant tissue as manifested at the growing surfaces of a malignant new growth, are effected by cell divisions which, so far as they are mitotic, conform to the ordinary type met with in early development. The number of chromosomes entering the equatorial plate is constant in each species, and they undergo the usual longitudinal splitting. Passing from the growing margin towards the older parts of the growth, it is seen that some of the mitoses are characterised by the presence of bivalent chromosomes (heterotype), in number half that found in the younger parts. These heterotypes must be regarded as occurring late in the life-history of the cells in which they are present. The analogy of spermatogenesis suggests that the heterotype initiates a terminal phase in the life-history of the cancer cell as in the spermatocyte. While studying the changes which occur immediately after transplantation in a tumour of the mouse, nuclear changes were observed which presented a close similarity to a conjugation process. Subsequent observations (on more than 1000 tumours of all ages from three different primary sources) have tended to confirm this interpretation. Numerous secondary centres of growth are always found around the periphery of older tumours, and these secondary masses may in time outgrow that which preceded them. It is suggested that the cells which conjugate are those which have passed through a reducing division, but until the complete cycle is elucidated this must remain only a working hypothesis.

THE EVOLUTION OF THE HORSE.[1]

PROF. H. F. OSBORN referred to the three independent lines of research being carried on by Profs. Ewart, Ridgeway, and himself, and hoped that they would be able to bridge the interval which at present existed between the fossil, the historic, and the recent races of horses. He gave an account of the explorations, begun three years ago, of the American Museum, which were rendered possible by a liberal gift from the Hon. W. C. Whitney. The object of this research into the fossil history of the horse was to connect all the links between the Lower Eocene five-toed and the Lower Pleistocene one-toed horses, and to ascertain the relations of the latter to the horses, asses, and zebras of Eurasia and Africa. The first result obtained is the proof of the multiple nature of the evolution of the horse during the American Oligocene and Miocene periods. Instead of a single series, as formerly supposed, there are five—one leading to Neohipparion, the most specialised antelope-like horse which has ever been found; a second, of intermediate form, probably leading through Protohippus to Equus, as Leidy and Marsh supposed; a third leading to the Upper Miocene Hypohippus, a persistently primitive, probably forest- or swamp-living horse, with short-crowned teeth adapted to browsing rather than grazing, and with three spreading toes; this horse has recently also been found in China. A fourth and fifth line of Oligocene-Miocene horses became early extinct. This polyphyletic or multiple law is

[1] Abstracts of three addresses given in Section D of the British Association on August 23.

quite in harmony with the multiple origin of the historic and recent races of horses as recently established by Profs. Ridgeway and Ewart. The Pliocene horse of America still requires further exploration before it can be positively affirmed either that all the links to Equus are complete or that America is indubitably the source of this genus. The Lower Pleistocene of America exhibits a great variety of races, ranging in size from horses far more diminutive than the smallest Shetland to those exceeding the largest modern draught breeds—yet all these races became extinct, and did not survive into the human period as was the case in South America. The relations of these North American races to those of South America and of Asia and Africa is a subject requiring further investigation.

The address was illustrated by photographs of a large series of models, of osteological preparations showing the mechanism and breeds of the horse, and of the mounted fossil specimens recently discovered.

Prof. Ewart referred to the fact that in pre-Glacial times there were several distinct species of Equidæ in the New World, and that one of the objects of present inquiry is to connect the recent Equidæ with these or other extinct forms. Before it is possible to point out the connection between the true horses and the pre-Glacial or Pleistocene horses it is necessary to determine the number of species and varieties of the horse now extant. He described at some length Prjevalsky's horse, the Norse type of horse still found fairly pure in the north-west of Scotland, and the recently discovered Celtic pony. He referred to Prjevalsky's horse as the least specialised of living Equidæ, as evidenced by the character of its mane and tail and the presence of a complete set of callosities, and he discussed the question as to whether it is a mule or simply the offspring of Mongolian ponies run wild. The Norse type of horse differs from Prjevalsky's in its heavy mane and tail, finer head, and smaller ears. The Celtic pony is the most specialised of living Equidæ, as shown by the absence of such vestiges as fetlock-pads and chestnuts from the hind legs, and the presence of a peculiar tail-lock which adapts it for a sub-arctic habitat. Photographs were shown to illustrate these various features.

Prof. Ridgeway then stated some of the evidence which led him to conclude that a distinct species or variety of the horse had been specialised in North Africa. Darwin supposed that not only was the Arab horse the result of artificial breeding by the Arabs, but that the dark colour of the English racehorse was due to the Arab dislike of light coloured horses. History puts it beyond doubt that the Arabs had no horses at the beginning of the Christian era, and that they obtained their famous breed from North Africa, and, so far from their disliking light coloured horses, they have a predilection, on religious grounds, for white or grey horses, as had the Germans, Greeks, and Romans. Bay and other dark coloured horses were well known in northern Africa and western Asia many centuries before the Arabs owned horses. The horse appears for the first time on Egyptian monuments about 1500 B.C., and is almost always painted brown, and those ridden by Libyans and depicted on pottery (at Daphne, B.C. 660–570) are always painted dark. These horses were not imported into northern Africa from Asia; on the contrary, Solomon (tenth century B.C.) and his neighbours imported horses from Egypt which must have been of a superior race. These horses were obtained from the Libyan tribes (as none of the other peoples in that region possessed them), and from them also came those of southern Spain, the ancestors of the Andalusian and Pampas horses. The Libyan horses passed into Sicily and southern Italy, and in the games of Greece and in Roman times they were the fleetest known. The bay horse therefore not only belongs to Africa from the earliest times, but was then, as now, the swiftest. The Libyan horses show a greater tendency to stripes than do Asiatic horses, and the former often lack hock callosities, which are present and of large size in coarse Asiatic horses. The tail of the Libyan horse differs in structure, covering, and carriage from that of Asiatic horses; the hoofs are longer, and the neigh is different. Libyan horses were docile, and could be driven without bit, while the peoples who used Asio-European horses invented the bit. Prof. Ridgeway concludes that *Equus caballus libicus* is to be regarded as a distinct variety.

THE ACTION OF WOOD ON A PHOTOGRAPHIC PLATE IN THE DARK.[1]

IT has been shown in former papers that many substances are capable of acting on a photographic plate in the dark and producing a picture of themselves. Further investigation shows that this property belongs probably to all woods, some, however, being much more active than others.

To obtain a picture the wood has to be in contact or at a little distance above the photographic plate, and has to remain there for times varying from half an hour to eighteen hours, and to be at a temperature not higher than 55° C.

The wood of the conifers is very active, and gives pictures which are very definite. Fig. 1 is a picture of a section of a branch of a Scotch fir, and shows well the rings of spring and autumn growth. It is remarkable that the former are very active, producing in this picture the dark rings, and so with the other pictures, the part which is active in the original is dark in the picture. The rings seen in the wood are very sharp and strongly pronounced in the picture. If the action exerted on the plate be owing to the presence of hydrogen peroxide, as has been previously suggested, no doubt it is produced by the resinous bodies

FIG. 1.

present in the wood, but it is remarkable that there is no action from the dark autumn wood. Experiments described in the full paper show that resin exists in the dark rings, but apparently under such conditions that it cannot escape. Other members of the pine group have been experimented with and have been found to behave in the same way as the Scotch fir.

With the spruces the action on the plate is not so definite and well marked; the white wood is always active, but in some cases the dark rings are also active, and the pictures are not so sharp as with the firs. Larch wood gives a very interesting result, for the picture is the reverse of that of the Scotch fir, that is, the dark rings in the wood are the active rings and the light rings are inactive.

With regard to woods other than conifers, oak and beech are both active and give very good pictures, so also does acacia (Robinia), Spanish chestnut, and sycamore; on the other hand, ash, elm, horse chestnut, plane are comparatively but slightly active. In the full paper lists of woods are arranged according to their activity.

Many foreign woods are very active, but as the annual rings are often not well developed, the pictures they give are of a somewhat different character. The African black wood, rose wood, cocobola, and many others are very active. Several of the foreign woods have a ring of white wood which is quite inactive.

[1] By Dr. William J. Russell, F.R.S. Read before the Royal Society, June 16.

Knots in a wood generally, but not always, give a good picture. Some of the resin in immediate contact with the knot is in some cases but little active. The marked difference in properties of resins from different sources is described, and it is shown how difficult it is to remove it so that the wood shall be no longer active. Boards that have been exposed to the air for a long time, an oak box a hundred or more years old, rotten wood from the stump of a tree, and even bog wood have all been found to be still active.

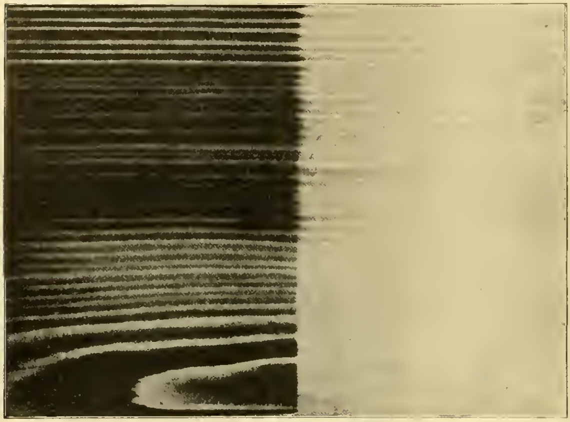

FIG. 2.

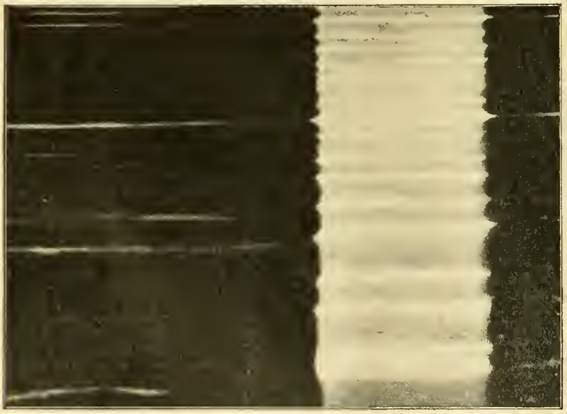

FIG. 3.

In addition to woods many different resins and allied bodies can, when used alone, be proved to be very active, some naturally much more so than others. Ordinary resins, Burgundy pitch, gum mastic, are very active, asphaltum, dragon's blood much less so, but true gums such as gum senegal and gum arabic are entirely without action on a photographic plate.

In certain cases the picture obtained on the plate does not resemble the markings which are visible on the wood. With some woods this more commonly occurs than with others. That this picture is persistent in the wood is shown by fresh sections giving the same result. The true bark of a wood is apparently quite without action on a photographic plate, so is the internal pith of a plant.

There is another and a very interesting action which occurs with wood; it is the great increase of activity which it exerts on a photographic plate after it has been exposed to a strong light. For instance, if a piece of deal be half covered by black paper or tin foil and be exposed for five to ten minutes to bright sunlight, and then put up in the usual way with a photographic plate, it will give a dark picture where the light has fallen on the wood and only a very faint picture of the part which has been covered. This is shown in Fig. 2. Even comparatively inactive woods such as elm and ivy after a short exposure to bright light give good and dark pictures. The action is not an indiscriminate darkening over the whole wood section, but an intensifying of the parts already active. This increase of activity by the action of light appears to occur with all woods. Artificial light, such as that from the electric arc, or from burning magnesium ribbon, act in the same way, so does even a faint light. A piece of wood put at a window for some hours will give a darker picture than a similar piece left in the middle of the room. This increase of power of a wood to produce a picture does not rapidly pass away. After twenty-four hours the action is visibly less, and decreases more rapidly at first than after some days, but it will be a fortnight or may be a month before the wood resumes its former condition. This action, like the former one, is entirely stopped by interposing the thinnest piece of glass or mica between the photographic plate and the active body. An inactive card painted with an alcoholic solution of resin acts in the same way, and turpentine which has been exposed to a bright light acts more strongly on a photographic plate than it does when it has not been so exposed. Again, old printing which is now nearly inactive becomes much more active after exposure to sunlight. Bodies other than those which may contain resin or allied substances are not affected in this way by light, for instance, flour, sugar, porcelain; metals are not rendered active by sunlight.

The next point was to ascertain which of the constituents of light was most active in producing these effects, and the first experiments were made by simply placing strips of different coloured glass on wood sections, exposing them to sunlight and afterwards putting them up with the photographic plate in the usual way. Pictures of the results are given in the paper. Red glass entirely prevented any increase in the activity of the wood, in fact, it acted in the same way as a band of black paper or tin foil would act, and a green glass acted much in the same way, but under a blue glass the activity of the wood was increased to much the same extent as under colourless glass or under no glass. Fig. 3 shows what happens when a red glass and a white glass are placed upon it and is exposed to sunlight. On the right of the figure there was no glass.

Further experiments were made by placing similar pieces of deal in light which had passed through different coloured solutions. Three double-cased bell jars were taken; one

was charged with a solution of potassium bichromate, another with copper ammonium sulphate solution, and the third with pure water, and all were exposed to sunlight for four hours. The deal in the red light gave only a faint picture, that in the blue light a dark picture, and that with the pure water was only a slightly darker picture. Resin, guaiacum, copal varnish, white oil paint and resin sized paper all acted in the same way and gave similar results.

The light from an arc lamp when passed through a red glass and allowed to fall on a wood section for one and a half hours produced no effect, but when the same light was passed through a blue glass and fell on a similar wood section for only one hour it produced a dark picture. With liquids this same increase of activity by the action of blue light is produced. Turpentine, which has been exposed to blue light, is more active than when in its ordinary condition.

THE DENSITY OF NITROUS OXIDE.[1]

IN the *Proceedings*, vol. lxxii. p. 204, 1897,[2] I have given particulars of weighings of nitrous oxide purified by two distinct methods. In the first procedure, solution in water was employed as a means of separating less soluble impurities, and the result was 3·6356 grams. In the second method a process of fractional distillation was employed. Gas drawn from the liquid so prepared gave 3·6362. These numbers may be taken to represent the corrected weight of the gas which fills the globe at 0° C. and at the pressure of the gauge (at 15°), and they correspond to 2·6276 for oxygen.

Inasmuch as nitrous oxide is heavier than the impurities likely to be contained in it, the second number was the more probable. But as I thought that the first method should also have given a good result, I contented myself with the mean of the two methods, viz. 3·6359, from which I calculated that, referred to air (free from H_2O and CO_2) as unity, the density of nitrous oxide was 1·52951.

The corresponding density found by M. Leduc is 1·5301, appreciably higher than mine; and M. Leduc argues that the gas weighed by me must still have contained one or two thousandths of nitrogen.[3] According to him the weight of the gas contained in my globe should be 3·6374, or 1·5 milligrams above the mean of the two methods.

Wishing, if possible, to resolve the question thus raised, I have lately resumed these researches, purifying the nitrous oxide with the aid of liquid air kindly placed at my disposal by Sir J. Dewar, but I have not succeeded in raising the weight of my gas by more than a fraction of the discrepancy (1·5 milligrams). I have experimented with gas carefully prepared in the laboratory from nitrate of ammonia, but as most of the work related to material specially supplied in an iron bottle I will limit myself to it.

There are two ways in which the gas may be drawn from the supply. When the valve is upwards, the supply comes from the vapourous portion within the bottle, but when the valve is downwards, from the liquid portion. The latter is the more free from relatively volatile impurities, and accordingly gives the higher weight, and the difference between the two affords an indication of the amount of impurity present. After treatment with caustic alkali and sulphuric acid, the gas is conducted through a tap, which is closed when it is desired to make a vacuum over the frozen mass, and thence over phosphoric anhydride to the globe. For the details of apparatus, &c., reference must be made to former papers.

The first experiment on July 13 was upon gas from the top of the bottle as supplied, and without treatment by liquid air, with the view of finding out the worst. The weight was 3·6015, about 35 milligrams too light. The stock of material was then purified, much as in 1896. For this purpose the bottle was cooled in ice and salt[4] and allowed during about one hour to blow off half its contents, being subjected to violent shaking at frequent intervals. Subsequently three weighings were carried out with gas drawn from the bottom, but without treatment by liquid air. The results stand:—July 18, 3·6368; July 20, 3·6360; July 25, 3·6362; mean, 3·63633.

Next followed experiments in which gas, still drawn from the bottom of the bottle, was further purified by condensation with liquid air. On one occasion (August 7) the condensed gas was allowed to *liquefy*, for which purpose the pressure must rise to not far short of atmospheric, and to blow off part of its contents:—August 1, 3·6363; August 3, 3·6367; August 7, 3·6366; mean, 3·63653.

The treatment with liquid air raised the weight by only 0·2 milligram, but the improvement is probably real. That the stock in the bottle still contained appreciable impurity is indicated by a weighing on August 13, in which without liquid air the gas was drawn from the *top* of the bottle. There appeared, August 13, 3·6354, about 1 milligram short of the proper weight.

It will be seen that the result without liquid air is almost identical with that found by the same method in 1896, and that the further purification by means of liquid air raises the weight only to 3·6365. I find it difficult to believe that so purified the gas still contains appreciable quantities of nitrogen.

The corresponding weight of air being 2·3772,[1] we find that, referred to air as unity, the density of nitrous oxide is $3·6365/2·3772 = 1·5297$. Again, if oxygen be taken as 16, the density of nitrous oxide will be $3·6365 \times 16/2·6276 = 22·143$.

The excess above 22 is doubtless principally due to the departure of nitrous oxide from Boyle's law between atmospheric pressure and a condition of great rarefaction. I hope shortly to be in a position to apply the connection which will allow us to infer what is the ratio of molecular weights according to Avogadro's rule.

[1] By Lord Rayleigh, O.M., F.R.S. Abridged from a paper received at the Royal Society on September 1.
[2] Or "Scientific Papers," vol. iv. p. 350.
[3] "Recherches sur les Gaz" (Paris, 1898.)
[4] The lower the temperature below the critical point, the more effective is this procedure likely to be.

[1] Roy. Soc. Proc., vol. liii. p. 134, 1893; "Scientific Papers," vol iv. p. 47.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. ERNEST SHEARER, Kirkwall, has been appointed lecturer on agriculture at the Pusa Imperial College, Bengal. This model agricultural college for all India, with a farm of 1300 acres attached, is one of the admirable developments resulting from the appointment two or three years ago of Mr. James Mollison as Inspector-General of Agriculture in India. Mr. Alexander Sangster, Montrose, has been appointed junior assistant with the Aboukir Land Reclamation Co., near Alexandria, Egypt, and Mr. John C. Leslie assistant conservator of forests in southern Nigeria.

THE approach of the new sessions at polytechnics and similar institutes is heralded by the appearance of calendars and prospectuses, several of which have been received within the past few days. At the Birkbeck College, Chancery Lane, the session will commence on Monday, October 3, when an inaugural address will be delivered by Dr. J. E. Mackenzie on "The Influence of Pure Science on Progress." The class-rooms and laboratories of the college will afterwards be open to inspection, and demonstrations will be given. A course in science with practical work has been organised to give complete preparation in metallurgy and mining for those qualifying for the mining profession. It is satisfactory to know that within the last few years valuable reference libraries have been provided for the separate departments of science; these have been aided by grants from the County Council. His Majesty's Treasury recently presented to the college forty-nine volumes of the scientific results of the *Challenger* Expedition.

THREE prospectuses have been received from the South-western Polytechnic, referring respectively to the day college for men and women, day school for boys and girls, and evening classes. The principal of the polytechnic is Mr. S. Skinner. The courses at the day college are arranged to occupy three years. On entering the student has to state whether he wishes to be trained as a mechanical, civil, or electrical engineer, or as a consulting or industrial chemist. In any of these cases he will find mapped out for him a complete course of study, involving laboratory instruction, tutorial work, attendance at lectures, exercises in mathematics, geometrical, mechanical and architectural drawing, and instruction in the workshops.

In the "Announcements" of the Northampton Institute, London, E.C., a table is given showing the courses which should be taken by various classes of technical students. This, as well as the sound advice given in many parts of the prospectus as to aims and methods of study, should be of great assistance in guiding the energies of students in right directions. Among the new developments of the institute are day courses in technical optics. These are believed to be the first complete day courses in technical optics attempted in this or any other country. In mechanical and electrical engineering complete day courses extending over four years are arranged. In mechanical engineering full evening courses for automobiles, their design, construction, and working, are offered. The courses in structural engineering have been re-modelled. The evening courses in electrical engineering have also been re-modelled, the complete course now covering five years.

The Board of Education has issued the following list of candidates successful in this year's competition for the Whitworth scholarships and exhibitions:—Scholarships, 125*l*. a year each (tenable for three years): Walter A. Scoble, London; Herbert G. Tisdall, Bedford; James Cunningham, Glasgow; Archibald D. Alexander, Portsmouth. Exhibitions, 50*l*. (tenable for one year): Sidney R. Dight, Plymouth; Edwin S. Crump, Wolverhampton; Harold H. Perring, Devonport; Sidney H. E. May, Portsmouth; William B. Wood, Sheerness; Alexander R. Horne, Edinburgh; Leslie G. Milner, London; John Wharton, Leeds; Thomas A. Colville, Chatham; Edward L. Macklin, Portsmouth; William D. McLaren, Glasgow; Arthur A. Rowse, Southsea; Arthur Rose, Portsmouth; Andrew Robertson, Fleetwood, Lancs.; Ernest J. Buckton, London; Roderick Ferguson, Sunderland; William Browning, Halifax; William Dawson, Glasgow; Herbert G. Taylor, Oldham; Sydney Moor, Devonport; Harold H. Broughton, Brighton; Robert C. P. Bricknell, Devonport; William E. Dommett, Southsea; John S. Mackay, Liverpool; Harry D. Marlow, Plumstead, Kent; Herbert E. Sothcott, Portsmouth; Sidney G. Winn, London; Samuel W. Orford, Sheerness; Thomas Fell, Bootle; Chauncy H. Sumner, London.

At the annual meeting of the Institution of Mining Engineers, held at Birmingham on September 14, Prof. R. A. S. Redmayne described the courses of instruction and study of the mining department of the University of Birmingham. The full three years' curriculum has been constructed on the principle of giving a thorough grounding in pure science during the first two years (with instruction in the theory and practice of mining), and devoting the third and last year entirely to the application of the scientific knowledge so acquired to engineering—mining, mechanical, civil, electrical, and metallurgical—all specialising and research work being relegated to a post-graduate or fourth year. The first year's work is devoted to such subjects as prospecting and boring, sinking, underground development and systems of working, surface and underground transport of minerals, winding, drainage, ventilation, sorting and screening of minerals, and surveying and planning. During the second year the details of colliery and mine management and mining jurisprudence are considered, in addition to which there is an advanced course in surveying and planning. To the third year is consigned the study of the foreign coal and metal mining conditions, and the dressing and preparation of fuels and ores for the market. There is a summer school of practical mining in every long vacation, the object being to devote several weeks in each year entirely to the detailed study of the plant and methods of working of a particular class of important mines, so that students may see for themselves in actual practice much that they have had described to them in the lecture theatre and class-rooms. An experimental coal-mine has been constructed a few feet below the surface, with which it is connected by a downcast and upcast shaft. The workings, the area of which somewhat exceeds three-quarters of an acre, will be ventilated by a single-inlet Capell fan, driven at 500 revolutions per minute by an electric motor of 20 horse-power, coupled direct; and they will be drained by a small electric pump placed at the bottom of the downcast shaft. The chief use to which this piece of apparatus will be put will be to enable practical instruction to be given in underground surveying and levelling, and connecting surface and underground surveys; and for demonstrating and investigating the peculiarities of mine-ventilation, such as the splitting of air currents and directing their course, the resistance to air currents, the loss of pressure due to friction, and the characteristics of mechanically produced ventilation.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 12.—M. Mascart in the chair.—On the comparative morphography of the cartilaginous cell: Joannes **Chatin**. The author disputes the generally accepted view that the normal shape of the cartilage cell is ovoid or spheroidal in the higher vertebrates, and shows that in cartilage from the badger there are undoubted examples of the stelliform type of cell.—The influence of grafting on the composition of the grape: G. **Curtel**. Clear evidence of differences in physical and chemical composition between grafted and non-grafted grapes has been obtained, and the facts observed explain the more rapid ageing of wines from grafted vines, and also their greater sensitiveness to pathogenic ferments.—Simple traumatic dislocation of the atlas on the axis on a skeleton found in a megalith of Vendée: Marcel **Baudouin**.—Observations on the preceding note: M. **Lannelongue**. The author regards the effects noted as probably due to *post mortem* changes.

CONTENTS.

THURSDAY, SEPTEMBER 29, 1904.

PETROLEUM.

The Oil Fields of Russia, and the Russian Petroleum Industry. By A. Beeby Thompson, A.M.I.M.E. Pp. xviii + 504; plates and maps. (London: Crosby Lockwood and Son, 1904.) Price 3*l.* 3*s.* net.

THE aspect of this large and attractive, well printed, and freely illustrated addition to the enormous literature of the Russian oil fields (which extends to many hundreds of books and articles) excites hopes of a comprehensive summary of the principal facts dispersed through the unwieldy mass of record, and of a formulation of the laws of which those facts are the tangible expression. Such a summary is a great desideratum, for, apart from the polyglot condition of the recorded information, and the difficulty of access to the original sources in the files of Caucasian journals and unpublished records, the subject is one demanding the conjoint forces of the geologist, the chemist, and the physicist, whilst the past has shown that conclusions reached by the study of any of these branches separately may directly traverse those based on other categories of data.

The title-page sets forth the aim of the work as a practical handbook on the exploration, exploitation, and management of Russian oil properties, with collateral considerations on the origin of the petroleum and the modes of its utilisation as fuel. The statistics of production constitute Appendix A (pp. 399–432), and forty-five pages of official regulations form Appendix B, which is followed by some useful tables of physical and other data, and a few pages treating of the latest developments in exploration and utilisation.

The value of the work lies principally in its technical element, based on several years' practical experience in the region, whilst it merits attention, with or without acceptance, on the scientific side, which is dealt with somewhat too theoretically. In regard to geological matter the treatise is disappointing, as we have an excess of general lithological detail, but the scantiest stratigraphical information. Fuller indications in this respect, with less and better founded speculation as to primæval conditions of deposition, would have made the book of higher utility in regard to its first stated aim, that of assistance in exploration for oil. For this accurate details of composition and structure (including correlation from point to point) are essential, and such are regrettably absent from the work under consideration.

We must demur, at the outset, to the alleged conformability of the Aralo-Caspian surface-beds to the oil-bearing Oligocene and Lower Miocene strata, a view which is probably the cause of the author's rejection of the anticlinal structure as the predominant factor in concentrating the petroleum along the axes of flexure. The assumption (p. 60) of the existence of synclines equally rich with the anticlines is one not warranted by the results of operations in any oil field of known structure, and therefore where, as in the Baku fields, the structure of the petroliferous series is masked by an unconformable superincumbent mass, the flexures in which are discordant in strike with those of the subjacent rocks, positive evidence of productive synclinals may legitimately be demanded in place of mere hypothetical surmise of the existence of such beyond the depth accessible by the drill. The natural exudations, mud volcanoes, and gas discharges are all situated on anticlinal axes, exposed by denudation of the Quaternary cover.

We cannot, for the simplest of chronological reasons, accept the suggestion of the oleaginous quality of the sturgeon and other Caspian fish as having any bearing whatever on the origin of the Caucasian petroleum (p. 64), and no evidence is advanced of kinship of the Oligocene with the existing ichthyofauna. (It is not imagined, *per contra*, that caviare is a modified bitumen.)

Briefly reviewing various theories as to the origin of petroleum, and noting the possibility of its being of different source in separate areas, the author wholly rejects, on adequate geological grounds, the hypothesis of inorganic origin; whilst from the scarcity in the series of the remains either of fibrous vegetation or of diatoms, he doubts the contribution, from the vegetable kingdom, of much, if any, of the enormous bulk of Caucasian petroleum. The large percentage of carbonate and phosphate of lime in the rocks points, on the other hand, to abundant animal life, but the author, gratuitously assuming the æolian character of the oil sands, gives, we think, too much rein to imagination in invoking periodical sandstorms from hypothetical deserts to effect sudden extinction of these deep-sea organisms over limited areas, and their entombment in similarly limited patches of the deposited sand, now converted into "pockets" charged with the resulting petroleum. The belief in catastrophic hecatombs of this nature is some three generations out of date, and can only be regarded as a superstition. Not only is the abnormally lenticular structure of the oil sands hypothetical, the data obtained by boring being equally explicable by reference to faulting, but sandstorms that should, for a few score yards only, saturate a deep sea to the degree of suffocation of its denizens, must have been evoked by the Genius of Destruction from Arabian or other Oriental deserts, and the existence of such deserts in Oligocene times, when continuous sea united the Atlantic and Pacific Oceans in these latitudes, is more than doubtful.

In dealing with the Grosny field, and the isolated spots in Daghestan that have yielded evidence of oil, the author mentions the difference in lithological character between these and the Baku fields, but without the explanatory information that these northern fields are of a different geological series, the Lower Miocene, whereas most, if not all, the Baku oil comes from Oligocene beds, though traces of Miocene occur in the southern part of the province.

The term "excitement" is applied by the author in a new technical sense to designate the disturbance of the equilibrium of a region by the rapid discharge, through borings, of fluids and discrete solids previously under great pressure, and the effect of the sudden arrests and renewals of the flow owing to temporary chokings of the exit. The widespread vibrations pro-

duced necessarily afford partial relief or re-adjustment to somewhat remote and disconnected seats of pressure during the moments of oscillation. Similar causes in the American fields have led to the appearance of gas in wells that at first produced only oil or water, and *vice versâ*, and in some cases a renewal of commercial activity in an abandoned field has been the result of operations at some distance away.

Apart from the defects referred to, the work is worthy of praise, for the engineering details, which constitute the bulk, are given in a form convenient for reference, and it is only needful to warn technical readers against too implicit acceptance of the author's views on some still unsettled scientific problems.

CHEMISTRY OF ALKALOIDS.

The Vegetable Alkaloids, with Particular Reference to their Chemical Constitution. By Dr. Amé Pictet. From the second French edition. Rendered into English, revised and enlarged, with the author's sanction, by H. C. Biddle, Ph.D. Pp. i.–vii. and 1–505. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.)

THIS translation of the second edition of Pictet's "La Constitution chimique des Alcaloïdes végétaux," with the numerous additions made by the translator, will be welcomed by many readers, for nearly seven years have elapsed since the appearance of the original, and in the interval great advances have been made in our knowledge of the alkaloids. The book is in no sense a monograph, as references to the sources, modes of extraction and detection, and physiological properties of the alkaloids are of the briefest, attention being concentrated on their purely chemical behaviour, and the clues thus given to their constitution and synthesis. A brief survey of the history of this important group of compounds is followed by a section dealing with pyridine, quinoline, and their derivatives, including the carboxylic acids which have played so important a part in the elucidation of the molecular structure of the plant bases. The remainder of the book summarises what is known of the chemical behaviour of twenty-eight groups of alkaloids, and in a final chapter a list is given of forty-two alkaloids of unknown constitution. It should be added that numerous references to original papers are supplied in footnotes.

All attempts to define an alkaloid by reference to chemical constitution have proved to be unsatisfactory. Restriction of the term to derivatives of pyridine, as was proposed by Koenigs, would exclude morphine and the xanthine bases, such as caffeine, and its extension to cyclic bases found in plants, whilst including these alkaloids, would not embrace such substances as asparagine, choline, and trimethylamine. The author employs the term in its widest sense, and groups together as alkaloids all those substances which are directly obtained from plants and able to unite with acids to form salts.

The systematic chemical investigation of the alkaloids, dating from 1869, when the constitution of pyridine was made clear, has been pursued with a remarkable degree of success. Putting aside acyclic compounds, constitutional formulæ have been assigned to some twenty-five bases, including such well known substances as morphine, quinine, atropine, cocaine, nicotine, and caffeine; and although less is known of the molecular structure of the others, it is significant of the energy with which inquiry has been pressed in this direction, that more than one hundred alkaloids—about one-half of the number recognised as definite chemical substances—have been examined with at least some measure of success. Whether the formulæ now regarded as probable will survive in every case may be open to doubt; it is, however, a striking testimony to the success attending modern methods of unravelling molecular structure, that in the case of no fewer than twelve of the twenty-five formulæ just mentioned the constitution assigned on the basis of analytical evidence has been confirmed by the synthetical preparation of the alkaloid. Much of this work has been done since the appearance of the French edition, and reference in particular may be made to the syntheses of the belladonna and coca alkaloids, and of the xanthine bases, accounts of which have been supplied by the translator, and form, perhaps, the most interesting chapters in the book.

The translator has done his work successfully on the whole, but it is to be regretted that more attention has not been paid to the nomenclature of carbon compounds. The Chemical Society in this country—in the annual reprint of instructions to its staff of abstractors—and the Geneva Congress, have done much to associate definite suffixes with particular groups of compounds, and it may be hoped that, nowadays, no author of a chemical text-book in English on this side of the Atlantic would, for example, write "benzol" and "pyrrol" for benzene and pyrrole respectively. In a new edition the use of laboratory slang should be avoided. Expressions such as "nitrogen-methylated" (p. 135), "it does not react alkaline" (p. 143), "dimethylcytisine will add methyl iodide" (p. 180), and "as a starting substance" (p. 228) are not happily chosen; whilst curiosity is stimulated by the statement that "a decomposition similar to this [the elimination of methylamine from tropine] is effected by the destructive distillation of Hofmann" (p. 204), since details of the latter process have so far been withheld from publication.

W. P. W.

NICKEL STEELS.

Les Applications des Aciers au Nickel, avec un Appendice sur la Théorie des Aciers au Nickel. By Ch. Ed. Guillaume. Pp. vii + 215. (Paris: Gauthier-Villars, 1904.) Price 3.50 francs.

A PROMINENT feature of the progress of steel during the last quarter of a century or so is the continued advance in the discovery and ever-widening practical application of what are known to the maker as "special" steels. "Ordinary" steels contain essentially certain well defined and usually small proportions of carbon, silicon, and manganese, varied to suit specific purposes, while sulphur, phosphorus, and even arsenic, though not desired, are seldom entirely

eliminated. "Special" steels contain other elements, or contain the ordinary elements in unusual proportions, as in the well known examples of Mushet's air-hardening tungsten steel, Hadfield's manganese steel, railway tyre chrome steels, nickel chrome armour plate steels, and so on, until at the present day, besides the elements just indicated, aluminium, copper, molybdenum, and even vanadium, which last is dearer than silver, are added to steels for commercial purposes, while other alloys are under experiment. It may well be imagined, then, with what eagerness the metallurgist turns to a monograph on any series of special steels, and particularly if it happens, as in the present case, to be written by a well known worker on the subject. Perhaps the title may mislead some general inquirers, for no doubt we are all looking for accounts of the experience of others in the innumerable applications, some experimental, some well established, of the steels of lower nickel content; but unless they were looking merely for guidance in the immediate work of manufacturing or using those steels, the feeling of disappointment would give way to one of great interest at the thorough manner in which certain properties of the steels of higher nickel content are discussed.

Practically the only steels seriously considered are those containing more than 26 per cent. of nickel. Within limits these are "reversible alloys," that is, "when they are brought to a determined temperature after having been run through any cycle of temperatures they retake sensibly the same properties." It is interesting to note that these alloys

"take a beautiful polish, lend themselves admirably to engraving, are sufficiently elastic when cold rolled to make passable springs though sensibly inferior to those of steel hardened and tempered. Resistance to oxidation varies with the nickel content and for well polished bars it is sufficient to go up to 36 per cent. nickel in order to be able without fear to leave them lying some hours or even days in water at ordinary temperatures. The reversible alloys work well in the lathe, in the planing machine, with the file or the drill on condition that the tool be strong and the attack slow. In general, working at too great a speed makes the alloys act in the same fashion as a grindstone and produces an extremely rapid wearing of the steel tool."

The work consists of four parts and an appendix. Part i. gives the dilatation and modulus of elasticity of the reversible alloys, and goes into great detail as to the amounts and variations of these under special conditions. These properties of the alloy of least dilatation containing about 36 per cent. of nickel, and the special annealing at temperatures less than 100° C. required to bring its wonderfully low dilatation practically to zero, and to bring almost to perfection its *invariability* under the greatest extremes of atmospheric temperature known, are most carefully described. Two new terms, widely accepted, should be noted here, *étuvage* for the low temperature annealing as distinct from *recuit*, high temperature annealing, and *invar*, an appropriate name for the alloy.

Part ii. is devoted to the application of these alloys, and particularly of invar, to the making of standards of length, and more especially for the measurement of bases in survey work (see NATURE, June 2, p. 104), with full details of the special wire standard. Part iii. treats of the uses and the limitations of the alloys in connection with chronometer pendulums, balances, and even springs. Part iv. takes sundry applications, some tried, some suggested, such as parts of levelling instruments, cathetometer and similar supports, bodies of astronomical telescopes, gravitation pendulums, balances, wires for operating signals, &c. Finally, the existence of invar, an alloy with a dilatation practically nil, suggests alloys of varying dilatations, hence special alloys (42 per cent. to 48 per cent.), with an expansion about equal to that of glass, for mounts of object glasses, incandescent lamps, Crookes's tubes, &c. In an appendix of twenty-seven pages the author gives his theory of the nickel steels. He abandons his former theory of compounds of iron and nickel, and, under the influence of MM. Osmond and Le Chatelier, works out an allotropic theory, of which space will not permit even a *résumé*.

This work is one that should be read not only by those particularly interested in the special matters with which it deals, but by all students of metals, as it forcibly drives home to the mind some of the characteristic properties of a remarkable series of alloys.

A. McW.

OUR BOOK SHELF.

Le Radium et la Radioactivité. By Paul Besson. With a preface by Dr. A. d'Arsonval. Pp. viii + 170. (Paris: Gauthier-Villars, 1904.) Price 3.75 francs.

THIS little volume is undoubtedly one of the best summaries that has yet appeared of the investigations that have followed from Becquerel's discovery, in 1896, of the radio-activity of the salts of uranium. The author has been associated with Prof. and Madame Curie in working up on a large scale the uranium residues from Joachimsthal, from which the salts of radium were commercially prepared. His account of the discovery of the radio-active elements, of their separation from the inactive elements in the ores, and of the methods employed in detecting and estimating their radio-activity, is exceedingly lucid and simple, and will appeal strongly to those who wish for a simple account of the phenomena as they presented themselves to the pioneer workers in this field of investigation. In view of the large amount of speculation that these investigations have aroused, it is one of the merits of the book that, whilst seven chapters are devoted to the description of the preparation and properties of the radio-active salts, the theoretical considerations are brought forward only in the last chapter. The disintegration theory, which at the present time dominates almost all that is written on this subject, occupies only a secondary place in the author's discussion of the source of the energy of radio-active bodies. He appears to lean rather to the view advocated by Filippo Ré in a short paper published in the *Comptes rendus* in June of last year, to the effect that the radio-active elements act as sources of energy not because they are in an unstable or explosive condition, but rather because they are still in process of formation. This view, which is derived from analogy with the liberation of energy in the solar system, has much to recommend it, as it eliminates the difficulty of accounting for the relatively slow rate at which the elements in question release the vast stores of energy which they are supposed, by the advocates of the disintegration theory, to contain.

The physiological effects produced by the radium salts are described in considerable detail, and the author looks for important applications in this direction. Thus, whilst the book is addressed to all those who are likely to be interested in the subject, especial care has been taken to state in detail those observations that are of importance to students of medicine and surgery. The developments that have taken place in recent years in the application of physical methods to the cure of disease justify the argument, which forms the main part of Prof. d'Arsonval's preface, that the study of physics should occupy an important place in a medical curriculum.

Chemical Laboratories for Schools. By D. S. Macnair, Ph.D., B.Sc. Pp. 24. (London: George Bell and Sons, 1904.) Price 6*d*.

ON the title-page of this little pamphlet are the words: "Hints to teachers as to the method of planning and fitting-up a school laboratory and of conducting a school course in chemistry." As the term "school laboratory" is extremely vague, each school or group of schools nowadays having a definite place in an organised system of education, some indication of the class of teacher to which the author wishes to appeal would have been advisable. Apparently the instruction is to be essentially of an elementary nature, and judging by the numerous suggestions regarding balances, weights, &c., weighing operations occupy an important place in the work.

The chief features and fittings of the laboratory are briefly dealt with in a simple manner. One notices that several dimensions, such as width of benches, height of bench-shelves, &c., are somewhat less than those usually adopted. More information might have been given regarding inexpensive materials suitable for pipes and other surfaces exposed to chemicals and fumes. For drain-pipes, fireclay or glass-lined iron is suggested; the former is seldom employed, as stoneware is found to be less porous, and on iron a coating of Dr. Angus Smith's mixture is generally preferred to a hard, brittle lining of glass.

A plan is given of a laboratory for twenty pupils: it is probably from an existing building, but to place 17-foot benches with one end against the wall is not an ideal arrangement, and another side-window appears desirable; continuous desks would be cheaper and more convenient than dual desks arranged *en bloc*.

Much admirable advice is given regarding the management of practical classes. Finally, considerable space is devoted to a carefully compiled list of the apparatus and chemicals required for a class of twenty pupils; each piece of apparatus is approximately priced, but the allowance for some items is liberal.

After all, the contents of this pamphlet seem more suitable to be included in the author's "Introduction to Chemistry" than for separate publication, even at the low price of sixpence.

Photo Printing. By Hector Maclean, F.R.P.S. Pp. 100. (London: L. Upcott Gill, 1904.) Price 1*s*. net.

THIS is a second and revised edition of the author's "Popular Photographic Printing Processes," and forms a practical guide to the use of the leading kinds of the so-called printing-out papers, as well as bromide papers, platinum papers, and carbon tissues. We notice that no reference is made to "ozotype," though this is a carbon process that has been growing in favour for some years, and the materials for its practice are supplied commercially. The volume is what it claims to be, namely, a practical guide to the use of commercial papers, and a condensed price-list of the goods of the principal makers is added to each chapter. It may be safely recommended to those who wish to print by the processes described, for the author is himself a practical worker, and has evidently bestowed considerable care on the collection of the information that he gives. Deviations from strictly practical directions are rare and generally unfortunate, if not unintelligible. These are a few details to which we would take exception. The expression "half the foregoing temperature" may convey the meaning intended, but it is incorrect. The use of "photo" in the title as a separate word instead of as a prefix is unnecessary and objectionable. The statement that "gelatino-chloride prints may be completely washed in ten minutes, provided" . . ., &c., is set down as a fact, though we think the evidence is rather against it so far as practical work is concerned. Much less are we prepared to accept the statement that three changes of water, allowing one ounce in each bath for each quarter-plate print, will serve to free the prints "as completely as possible from 'hypo.'" The classification of platinum printing as a "partly print out" process is an illustration of the purely "practical" character of the work.

Œuvres scientifiques de L. Lorenz. Edited and annotated by H. Valentiner. Vol. ii. Second Fascicule. Pp. xxii + 319–583; with portrait. (Copenhagen: Lehmann and Stage, 1904.)

THIS concluding fraction of the papers of Lorenz is prefaced with an interesting critical account of his life and works. We see the young Lorenz largely self-taught, preferring to work out problems independently, although the result was usually to find out that they had been solved long before. It was in this laborious way that his mathematical gifts were developed. Owing to indifference to the usual courses of instruction, there was little sympathy between him and his teachers, and he left the Copenhagen Polytechnic without distinction. Be that as it may, by the year 1887 he had become a Councillor of State, and had received the honorary degree of Doctor of Philosophy of the University of Upsala.

Lorenz's scientific works are, in the main, on mathematical physics—sometimes leaning to the mathematical side, sometimes to the physical side. The editor of the present collection is alive to the lack of lucidity which characterises many of these. This is especially so when no experiments are forthcoming by which the results obtained can be tested.

The best known of his papers have appeared in preceding fascicules. The present one contains those of more mathematical interest. Of these the most important is probably one on the development of arbitrary functions by means of given functions, these being the functions of Bessel. Other memoirs are on the compensation of errors of observation, and analytical researches on the number of prime numbers. Lorenz's genius was, however, essentially physical; and although many of his mathematical conclusions are valid, they have been reached by insight more than by the application of logic such as a mathematician demands.

A portrait is presented with this instalment of the collection.

Botany Rambles. Part iii. In the Autumn. By Ella Thomson. Pp. 253—377. (London: Horace Marshall and Son, 1904.) Price 1*s*.

THIS is the third of a series of simple books in which the parts and functions of common wild plants are described for young readers. The present book is concerned chiefly with seeds and the means by which they are dispersed. Children who read the pages will have their attention directed to many points commonly overlooked, and if they test the statements by personal observation and practical study—as they are advised to do—they will be given both knowledge and pleasure.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Average Number of Kinsfolk in each Degree.

WHAT is the average number of brothers, sisters, uncles, nephews, nieces, first cousins, &c., that each person possesses? I had occasion to compute this for a particular collection of persons; the results were so far unexpected as to show that the question deserved a consideration which it has not yet received, so far as I am aware. The problem proved easy enough in the end, but not at first, for there are other ways of attacking it, in which I blundered and lost time.

The simplest conditions that will serve for a general theory are those of a supposed population (1) the numbers of which are statistically constant in successive generations; (2) the generations of which do not overlap; and (3) which are "completed" by having wholly passed into history; and again (4) where every person is taken into account, at whatever age he or she may have died. It will be a further great simplification if it be allowed (5) to suppose the males and females to be equal in number, and in all respects to admit of similar statistical treatment. This need be only a provisional way of looking at the problem, for it will be seen that corrections can easily be introduced if desired.

It will much facilitate matters to begin by dealing exclusively with either the male or the female half of the population, leaving the other half to follow suit. We will begin with the females.

Let d be the average number of female children born of each woman who is a mother, so if there be n mothers in the population the total number of females in the next generation will be nd. How many of these latter will prove fertile of female children? On the supposition of statistical constancy, the number of mothers in the two generations will be the same, therefore d out of the nd will be fertile of female children; conversely, the probability that any one of these female children will herself bear one or more female children $=1/d$. As a test of this, the average number of fertile daughters to each mother will be $d \times 1 \; d=1$, as it should be.

Next, as regards sisterhoods. Each mother bears on the average d female and d male children, or $2d$ individuals in all. Each of these will have $2d-1$ brothers and sisters, and half that number of sisters, namely, $d-\frac{1}{2}$.

The syllable *si* will be used to express "sisters" without regard to age or fertility, and *si'* to express "sisters who are fertile of female children"; similarly *da* and *da'* for daughters.

The number therefore of *si* is $d-\frac{1}{2}$, of *si'* it is $(d-\frac{1}{2})/d$, of *da* it is d, of *da'* it is 1. The number of *me'*, or of mothers to a child, is, of course, 1, and there is no occasion for using *me*, as a mother must be fertile.

A few examples of results are given in the following table; it could have been extended indefinitely, but these are quite sufficient for drawing conclusions:—

Specific kinships.		Average number in each	
ANCESTRY—			
me'	(mother)	1	1
me' me'	(mother's mother)	1×1	1
me' me' me'		$1 \times 1 \times 1$	1
COLLATERALS—			
si	(sisters)	$(d-\frac{1}{2})$	$d-\frac{1}{2}$
me' si	(mother's sisters)	$1 \times (d-\frac{1}{2})$	$d-\frac{1}{2}$
me' me' si		$1 \times 1 \times (d-\frac{1}{2})$	$d-\frac{1}{2}$
si' da	(sister's daughters)	$(d-\frac{1}{2})/d \times d$	$d-\frac{1}{2}$
me' si' da		$1 \times (d-\frac{1}{2})/d \times d$	$d-\frac{1}{2}$
si' da' da		$(d-\frac{1}{2})/d \times 1 \times 1/d$	$d-\frac{1}{2}$
DESCENDANTS—			
da	(daughters)	d	d
da' da	(daughter's daughters)	$1 \times d$	d
da' da' da		$1 \times 1 \times d$	d

The foregoing remarks and table are equally applicable to males if *bro* (brother) is substituted for *si*, *son* for *da*, *fa* (father) for *me*.

It will, then, be understood that each mother, father, or fertile couple has, on the average, d sons and d daughters, or $2d$ children altogether, of whom 1 is a fertile son, 1 a fertile daughter, and that the others die without issue. In the collection mentioned above, the value of d was about $2\frac{1}{2}$, that is to say, an average family consisted of about 5 children, which is a usual estimate.

It is unnecessary to prolong these remarks by considering the minor corrections to be supplied on account of the hypotheses not being strictly accordant with observation. The two most important of these relate to populations that are not stationary, and to the allowance to be made for inequality in number of the sexes. There are others hardly worth even the trouble of describing, being utterly insensible in rough work.

The general results are that kinships fall into three distinct groups:—(1) direct ancestry, (2) collaterals of all kinds, (3) direct descendants, and that the number of individuals in each *specific* kinship in these classes is respectively 1, $d-\frac{1}{2}$, and d. Also that $d=2\frac{1}{2}$ may be accepted as a reasonable and not infrequent value. To determine the number of individuals in each *general* kinship, the appropriate tabular number must be multiplied by the number of *species* that the *genus* contains; thus there are two species of aunts, *me si* and *fa si* (mother's sisters and father's sisters), each of which has the tabular number of $d-\frac{1}{2}$; therefore the average number of aunts is twice that amount, or $2d-1$, which, in the above case of $d=5$, is equal to 4.

FRANCIS GALTON.

The Mendelian Quarter.

A FEW weeks ago we heard in Section D at the Cambridge meeting of the British Association a paper by Mr. A. D. Darbishire on the bearing of his experiments in crossing Japanese waltzing and albino mice on Mendelian theory. He told us that on that theory we should expect a quarter of the offspring of the hybrids to be albinos—and we found them albinos—and a quarter of the offspring of the hybrids to waltz—and they did waltz. Somebody protested *sotto voce*, and Mr. Darbishire added "a rough quarter." Since that meeting I have been looking up the matter, for the point seems to me of great interest, and this is what I find in a recent paper by Mr. Darbishire in the *Manchester Memoirs*, "On the Bearing of Mendelian Principles of Heredity on Current Theories of the Origin of Species," vol. xlviii. p. 13:—"Let us consider the offspring of hybrids . . . . Secondly with regard to their progression, we should expect to find 25 per cent. waltzing mice: this is very roughly what happens; . . . Now let us look at the offspring of hybrids from *both* points of view at the same time: one mouse in every four is an albino; one in every four is a waltzer, so we should expect one in every sixteen to be an *albino waltzer*. Now these albino waltzers are new things . . .," and then Mr. Darbishire tells us that he has been unable to get offspring from them.

Here, from a quarter, we have got to a quarter "very roughly," but still "one mouse in every four is a waltzer." I must confess that Mr. Darbishire's "rough quarter" excited me to look further, and these are the words I find describing some actual experiments on these mice:—"*Waltzing* occurs in only 97 out of the 555 individuals resulting from the union of hybrids. When we compare this with the number of pink eyed individuals (131–134) or of albinos (137) we see that the proportion of waltzing individuals *cannot be regarded as a possible quarter*. The probable error of the expectation that a quarter of the individuals will waltz is, on the Mendelian hypothesis, $0{\cdot}6745\sqrt{\frac{1}{4}\times\frac{3}{4}\times555}=6{\cdot}88$ only, and the observed deviation is $138{\cdot}75-97=41{\cdot}75$, the odds against so great a deviation being rather more than 50,000 to 1. As the result here obtained differs from Mendelian expectation in the same direction as that already obtained by von Guaita and to an extent consistent with the agreement of both, *the evidence that the waltzing character does not segregate in Mendelian proportions is very strong*."

The sentences in italics are not in italics in the original,

but I want to emphasise them. The words quoted are from an article on the "Result of Crossing Japanese Waltzing with Albino Mice" in *Biometrika*, vol. iii. p. 20. The writer appears to be a Mr. A. D. Darbishire of Oxford, *not* of Manchester. The one Mr. Darbishire considers that the proportions cannot be regarded as a possible quarter, the other that a rough quarter, or "one mouse in every four," is waltzing. Mr. Darbishire of Manchester expects that one in every sixteen of the offspring of the hybrids will be an albino waltzer, and then proceeds to state that he has so far been unable to breed from these albino waltzers. Reading his paper, I presumed he would have told us had he *not* found albino waltzers to be 1 in 16. Consulting, however, Mr. Darbishire of Oxford, I find he had 20 instead of 35 albino waltzers among his 555 offspring. I presume that 20=35 is a "rough" sixteenth to our Manchester author, while he of Oxford would doubtless have been able to tell us that the odds against such an underestimate were two or three hundred to one! Which writer shall a member of the inquiring general public trust? Or, if the two writers should be the same, must we assume that in Oxford, under the influence of some recessive biometer, Mr. Darbishire failed to see that 97 in 555 was a reasonable quarter, or 20 in 555 a reasonable sixteenth, but that he has learnt in Manchester, or perhaps in Cambridge from some dominant anæsthetist, that these things really are so?

But if 97 be not even roughly 139, or 20 approximately 35, would it not be well at once to admit that the waltzing habit corresponds to a compound allelomorph, one element of which, the *chorophore*, may be credited to any mouse, but only becomes patent when combined with the *chorogen* to form the true waltzing habit? I am not sure this will work, but perhaps Mr. Darbishire will give it a trial. Should this in turn fail, a metaphysician might help him out of these procrustean difficulties by analysing straightforward advance into right-handed and left-handed elements, each with its own chorophore and chorogen—but I must not anticipate the details of such a remarkable progression at present.

KARL PEARSON.

The *n*-Rays.

THE inability of a large number of skilful experimental physicists to obtain any evidence whatever of the existence of the *n*-rays, and the continued publication of papers announcing new and still more remarkable properties of the rays, prompted me to pay a visit to one of the laboratories in which the apparently peculiar conditions necessary for the manifestation of this most elusive form of radiation appear to exist. I went, I must confess, in a doubting frame of mind, but with the hope that I might be convinced of the reality of the phenomena, the accounts of which have been read with so much scepticism.

After spending three hours or more in witnessing various experiments, I am not only unable to report a single observation which appeared to indicate the existence of the rays, but left with a very firm conviction that the few experimenters who have obtained positive results have been in some way deluded.

A somewhat detailed report of the experiments which were shown to me, together with my own observations, may be of interest to the many physicists who have spent days and weeks in fruitless efforts to repeat the remarkable experiments which have been described in the scientific journals of the past year.

The first experiment which it was my privilege to witness was the supposed brightening of a small electric spark when the *n*-rays were concentrated on it by means of an aluminium lens. The spark was placed behind a small screen of ground glass to diffuse the light, the luminosity of which was supposed to change when the hand was interposed between the spark and the source of the *n*-rays.

It was claimed that this was most distinctly noticeable, yet I was unable to detect the slightest change. This was explained as due to a lack of sensitiveness of my eyes, and to test the matter I suggested that the attempt be made to announce the exact moments *at which I introduced my hand* into the path of the rays, by observing the screen. In no case was a correct answer given, the screen being announced as bright and dark in alternation when my hand was held motionless in the path of the rays, while the fluctuations observed when I moved my hand bore no relation whatever to its movements.

I was shown a number of photographs which showed the brightening of the image, and a plate was exposed in my presence, but they were made, it seems to me, under conditions which admit of many sources of error. In the first place, the brilliancy of the spark fluctuates all the time by an amount which I estimated at 25 per cent., which alone would make accurate work impossible.

Secondly, the two images (with *n*-rays and without) are built of "instalment exposures" of five seconds each, the plate holder being shifted back and forth by hand every five seconds. It appears to me that it is quite possible that the difference in the brilliancy of the images is due to a cumulative favouring of the exposure of one of the images, which may be quite unconscious, but may be governed by the previous knowledge of the disposition of the apparatus. The claim is made that all accidents of this nature are made impossible by changing the conditions, *i.e.* by shifting the positions of the screens; but it must be remembered that the experimenter is aware of the change, and may be unconsciously influenced to hold the plate holder a fraction of a second longer on one side than on the other. I feel very sure that if a series of experiments were made jointly in this laboratory by the originator of the photographic experiments and Profs. Rubens and Lummer, whose failure to repeat them is well known, the source of the error would be found.

I was next shown the experiment of the deviation of the rays by an aluminium prism. The aluminium lens was removed, and a screen of wet cardboard furnished with a vertical slit about 3 mm. wide put in its place. In front of the slit stood the prism, which was supposed not only to bend the sheet of rays, but to spread it out into a spectrum. The positions of the deviated rays were located by a narrow vertical line of phosphorescent paint, perhaps 0·5 mm. wide, on a piece of dry cardboard, which was moved along by means of a small dividing engine. It was claimed that a movement of the screw corresponding to a motion of less than 0·1 of a millimetre was sufficient to cause the phosphorescent line to change in luminosity when it was moved across the *n*-ray spectrum, and this with a slit 2 or 3 mm. wide. I expressed surprise that a ray bundle 3 mm. in width could be split up into a spectrum with maxima and minima less than 0·1 of a millimetre apart, and was told that this was one of the inexplicable and astounding properties of the rays. I was unable to see any change whatever in the brilliancy of the phosphorescent line as I moved it along, and I subsequently found that the removal of the prism (we were in a dark room) did not seem to interfere in any way with the location of the maxima and minima in the deviated (!) ray bundle.

I then suggested that an attempt be made to determine by means of the phosphorescent screen whether I had placed the prism with its refracting edge to the right or the left, but neither the experimenter nor his assistant determined the position correctly in a single case (three trials were made). This failure was attributed to fatigue.

I was next shown an experiment of a different nature. A small screen on which a number of circles had been painted with luminous paint was placed on the table in the dark room. The approach of a large steel file was supposed to alter the appearance of the spots, causing them to appear more distinct and less nebulous. I could see no change myself, though the phenomenon was described as open to no question, the change being *very* marked. Holding the file behind my back, I moved my arm slightly towards and away from the screen. The same changes were described by my colleague. A clock face in a dimly lighted room was believed to become much more distinct and brighter when the file was held before the eyes, owing to some peculiar effect which the rays emitted by the file exerted on the retina. I was unable to see the slightest change, though my colleague said that he could see the hands distinctly when he held the file near his eyes, while they were quite invisible when the file was removed. The room was dimly lighted by a gas jet turned down low, which made blank experiments impossible. My colleague could see the change just as well when I held the file before his face, and the substitution of a piece of wood of the same size and

shape as the file in no way interfered with the experiment. The substitution was of course unknown to the observer.

I am obliged to confess that I left the laboratory with a distinct feeling of depression, not only having failed to see a single experiment of a convincing nature, but with the almost certain conviction that all the changes in the luminosity or distinctness of sparks and phosphorescent screens (which furnish the only evidence of *n*-rays) are purely imaginary. It seems strange that after a year's work on the subject not a single experiment has been devised which can in any way convince a critical observer that the rays exist at all. To be sure the photographs are offered as an objective proof of the effect of the rays upon the luminosity of the spark. The spark, however, varies greatly in intensity from moment to moment, and the manner in which the exposures are made appears to me to be especially favourable to the introduction of errors in the total time of exposure which each image receives. I am unwilling also to believe that a change of intensity which the average eye cannot detect when the *n*-rays are flashed "on" and "off" will be brought out as distinctly in photographs as is the case on the plates exhibited.

Experiments could be easily devised which would settle the matter beyond all doubt; for example, the following:—Let two screens be prepared, one composed of two sheets of thin aluminium with a few sheets of wet paper between, the whole hermetically sealed with wax along the edges. The other screen to be exactly similar, containing, however, dry paper.

Let a dozen or more photographs be taken with the two screens, the person exposing the plates being ignorant of which screen was used in each case. One of the screens being opaque to the *n*-rays, the other transparent, the resulting photographs would tell the story. Two observers would be required, one to change the screens and keep a record of the one used in each case, the other to expose the plates.

The same screen should be used for two or three successive exposures, in one or more cases, and it should be made impossible for the person exposing the plates to know in any way whether a change had been made or not.

I feel very sure that a day spent on some such experiment as this would show that the variations in the density on the photographic plate had no connection with the screen used.

Why cannot the experimenters who obtain results with *n*-rays and those who do not try a series of experiments together, as was done only last year by Cremieu and Pender, when doubt had been expressed about the reality of the Rowland effect? R. W. WOOD.

Brussels, September 22.

Porpita in the Indian Seas.

DURING five voyages to and from the East, I have been interested in watching for (and not always seeing) a species of Porpita common in the Red Sea, on the coasts of India, Ceylon, and the Malay Peninsula. From the deck of a steamer the colony, only the flat disc of which is visible, appears like a floating counter of bone or ivory. When examined at close quarters it has a greyish metallic lustre, and is seen to be surrounded with an aureole of azure tentacles, the tips of which are green. So long ago as 1579[1] Thomas Stevens appears to have remarked upon this animal (though he did not recognise its animal nature) as being one of the signs by which the vicinity of land might be known on the Indian coasts. During the monsoon, even in comparatively fine weather, this Porpita, so far as my observations go, completely disappears from the surface. It would seem to follow that the colony is an annual growth, as it has no power of sinking, and very feeble, if any, means of independent progression. This is borne out by an observation I was able to make on the shore at Colombo on July 15 last. On that date, when the monsoon had already been in progress for some weeks, the beach along the Galle face, which is open to the full force of the monsoon, was covered with biscuit-like discs, which I had no difficulty in recognising, from the sculpturing on their surface and the characteristic appearance in cross-section, as those of Porpita. They had quite lost their silvery appearance, and were very brittle; no trace of the living tissues of the animal remained. There were, however, large numbers of other Siphonophora, too decomposed for even partial identification (but obviously belonging to a different section of the group), mingled with the discs. My friend Dr. J. H. Ashworth tells me that he has observed much the same thing in the Mediterranean with regard to Velella, and it appears that Agassiz records having seen a broad blue band of Velella along the shores of Florida, but I have not the reference at hand. NELSON ANNANDALE.

Indian Museum, Calcutta, August 22.

[1] See Beazley's "Voyages and Travels," 1903, p. 158.

On van 't Hoff's Law of Osmotic Pressure.

VAN 'T HOFF imagines that a substance dissolved in a fluid medium behaves as if it were in a vacuum, and so exerts on the walls of the containing vessel a pressure which is precisely that which it would exert were the solvent imagined removed and the dissolved substance imagined present in a gaseous form.

The pressure thus exerted on the walls of the vessel is called the "osmotic pressure." Many authors of great mathematical repute have seriously questioned the correctness of van 't Hoff's views, and they find it exceedingly difficult to see how a dissolved substance *can* be present in the solvent in a state similar to the gaseous state.

For example, Prof. O. E. Meyer ("Kinetic Theory of Gases," p. 367, Eng. trans., 1896) remarks:—". . . osmotic pressure is not one of the phenomena which the kinetic theory of gases has to explain. I will also not conceal that I do not think van 't Hoff's views of the kinetic nature of osmotic pressure to be correct. For osmose does not arise from the kinetic pressure of the dissolved substance, but from quite different forces which cannot be neglected."

I think, however, these authors have neglected an important factor which would tend to make the dissolved molecules behave as if in a vacuum, and so would tend to give physical reality to van 't Hoff's views.

The factor I allude to is the fact that different kinds of molecules attract each other with enormously different forces. For example, the molecules of carbon exert on each other an enormous attractive force, as is shown by the remarkable hardness and involatility of certain forms of carbon. Oxygen, hydrogen, helium, and other molecules have in comparison but a feeble molecular attraction.

Consider a molecule A in the midst of a swarm of other molecules; for example, a molecule in the interior of a homogeneous liquid. Then if the molecule A be of the same nature as the other molecules, each will exert the same intensity of attractive force on the other, and so the molecules will all be on an average symmetrically arranged about A. The liquid will, in fact, have at every point a symmetrical structure. If, however, the molecule A be different in nature from the neighbouring molecules (as occurs in the case of solution), two cases in general occur:—

(1) The molecules of the liquid attract each other more strongly than they attract the molecule A.

(2) The molecules of the liquid attract each other *less* strongly than they attract the molecule A.

(1) In this case it is easy to see that under the influence of the molecular forces the molecules of the *liquid* would be *drawn* away from the molecule A (in precisely the same way, and for a similar reason, that the molecules of quicksilver are drawn away from glass), and so form about A a sort of *vacuum bubble*; and as A moves forward in the liquid the molecules surrounding it would be drawn away, and leave a free passage for A, which would thus behave very much as if it were actually in a vacuum. Here, then, van 't Hoff's conception becomes readily intelligible.

(2) In this case molecules of the liquid would combine with the molecule A to form an unstable compound, traces of which are so often met with in solution; and the combination would proceed until the compound thus formed exerted an attractive force on the neighbouring molecules equal to or *less* than the force which the neighbouring molecules exert on each other.

When this occurs the case would resolve itself into case (1) previously considered, the unit, however, being now not the molecule A, but the molecular compound of which it forms a part.

In this connection it should be observed that it is a general rule that when a molecule adds on atoms to itself, the resultant aggregate of atoms usually exerts an *intensity* of molecular attraction *less* than that of the original molecule. For example, high-grade types of combination are nearly always more volatile than lower types of combination of the same molecular weight. Saturated compounds are more volatile than unsaturated compounds of the same molecular weight. Chemically unstable compounds are invariably more volatile than stable compounds of the same molecular weight, and the addition of atoms to a molecule decreases its stability.

The point is discussed fully in a paper which appeared in the *Chemical News* some time ago (vol. lxxxix. p. 241).

We should therefore expect to find that when a substance A in a liquid combines with molecules of the liquid, the *intensity* of the molecular attraction which the new compound exerts would diminish as the number of molecules of the liquid added on to the molecule A increases.

When this is not the case, van 't Hoff's law cannot be obeyed at all closely by the dissolved substance.

Kiel, September 6. GEOFFREY MARTIN.

THE ROYAL PHOTOGRAPHIC SOCIETY'S ANNUAL EXHIBITION.

THIS exhibition will remain open until October 29. Although the scientific and technical section is disappointing, for, taken as a whole, it is below the standard of the last few years, there are several exhibits that are well worth attention. We are glad to notice an improvement in the arrangement, each department being kept more distinct than heretofore.

Zoological work is better represented than any other. Captain F. D. S. Fayrer shows several photographs of the daboia (a venomous viper), in one of which venom can be distinctly seen hanging from the fangs. As an example of photographic difficulties successfully overcome, the "Flying Sea Gull" of Mr. B. H. Bentley should be noticed. There are several sets of prints illustrating progressive changes. The one that will probably be considered the most notable is "A comparison of a jump of one foot in height as executed by a dog and a cat respectively." There are sixteen photographs of each animal showing as many stages of the jump, and they demonstrate that both animals judge with remarkable nicety the rise necessary to clear the obstacle, and that the movement of the legs is the same in both cases. "The Embryology of a Chicken," by Mr. W. M. Martin, is a series of seventy photographs, one by Röntgen rays, some by transmitted light, and some by a combination of transmitted and reflected light. It is clever and useful work which must have needed considerable patience for its execution. The Zoological Photographic Club has contributed a number of very interesting and meritorious photographs, including one by Mr. Douglas English of the Orkney vole, the last discovered British mammal.

Mr. R. H. Baskett shows how, by means of a simple original such as a piece of lace or a sprig of forget-me-not or bramble, many designs may be obtained by the use of mirrors as in a kaleidoscope, if the multiplied image is photographed. He says that millions of designs may be obtained for the cost of the plates. A truly amateur's view of the matter in neglecting the cost of the apparatus and the time of the worker!

Colour photography is but poorly represented. A basket of fruit by Mr. S. R. Brewerton, done by the Sanger-Shepherd imbibition process, is a notable example, but such fine work has been done by this method that we cannot pass over the background, which if not unfortunate in its tint has not been reproduced with the perfection that we expect. Of the specimens of commercial colour work there is little to be said. What is wanted for exhibition is the original with its reproduction, produced without any fine etching or other hand work; then we shall be able to see what colour photography pure and simple is capable of, and to judge of its progress. If the trichromatic prints produced by Dr. Jumeaux's process fairly show the capabilities of that process, we can only say that it is a long way behind other processes. Photographers should notice the "three-colour carbon print" by Mr. J. Gilbert Jackson, as for obvious reasons they are not likely often to have the opportunity of seeing prints produced in this way. The carbon tissue is triply coated, so that the high lights show blue, the half tones, ochre, and the low tones, green. Of course, the colour in the print is in no way dependent on the colour of the object. The interest of the exhibit lies only in the fact that the method has been seriously proposed for practical work.

A telephotograph of St. Paul's showing a direct magnification of twenty-four diameters demonstrates excellently the usefulness of this kind of work. A number of photomicrographs, some Playertype enlargements, some star maps, and a few other items are all worth examination; but the most notable of the remaining exhibits is a series of radiographs showing bone diseases by Mr. C. Thurstan Holland. The amount of detail obtained in difficult circumstances is remarkable, and the exhibit is further praiseworthy as forming a connected whole instead of, as we often see, a heterogeneous collection of examples that have happened to turn out well. We regret to notice that there is no apparatus whatever in this section of the exhibition. Probably the presence of the trade exhibits in the central court is the reason for the disappearance of what used to be one of the main sections, but general exhibits by the trade do not take the place of a classified selection of new apparatus. In the central court will be found new cameras, or modifications of old ones, by several makers, and some new sensitometric apparatus and a recording chronograph by Messrs. Sanger-Shepherd and Co., besides, of course, a large selection of the various specialities of the exhibitors.

Of lantern slides there is a fair number, and they appear to be of more than usual interest. A series by Dr. G. H. Rodman showing how by the use of Röntgen rays the structure of molluscan shells can be shown, and a series of studies in the biology of flowers by Mr. B. H. Bentley, are the most conspicuous. But we cannot discover when these can be seen properly displayed, for a slide is not made to be looked at, but to furnish an enlarged image on a sheet. It appears that at the lantern lectures, which are given at intervals, other slides are shown.

PROF. N. R. FINSEN.

THERE are many records of patient heroism in the history of scientific investigation, but there are few careers in which strenuous work for the alleviation of human suffering has been carried on at greater disadvantage than that of the late Prof. Finsen, of Copenhagen.

Twenty years ago, he was the victim of a severe attack of rheumatism, which left the heart seriously damaged, and this was followed by disease of the liver and dropsy. By the greatest self-denial, and the most careful regulation of his dietary, Finsen

lived on, in spite of his terrible affliction, devoted to his work, developing his theories, and putting them to practical use in the treatment of disease. For some time past he had been confined to his house, and could only direct the labours of others in the great Light Institute at Copenhagen. His death occurred on Saturday, September 24, at the early age of forty-three.

Niels R. Finsen was born in the Færoë Isles, and spent some of his earlier years in Iceland. After eight years' study at the University of Copenhagen, he was appointed lecturer on anatomy. But his attention was soon directed to the investigation of the influence of light on living organisms.

Starting from Widmark's observations on the inflammation of the skin caused by the ultra-violet rays of light, he developed in 1893 the red-light treatment of small-pox. The exclusion of the chemical rays by red curtains modifies the course of this disease, and diminishes scarring. A prolonged series of observations was then made on the influence of light upon various animals, proving that the chemical rays produce irritative and deleterious effects.

Later, Finsen investigated in a masterly manner the bactericidal power of the ultra-violet rays, a development of the work of Downes and Blunt. The practical application of these experimental researches was the treatment of lupus by light, an advance in therapeutics which has placed in the hands of the medical profession a means of combating this intractable and most disfiguring disease.

Fortunately, Finsen's work was not allowed to languish for want of financial support. His friends helped him, and then the State aided him with a loan, free of interest, and the Light Institute was built. Since it was opened, 2000 patients have been treated.

The interest taken by Queen Alexandra in the work of her countryman led to the introduction of the light treatment into this country, and her gift of the apparatus to the London Hospital was followed by generous assistance from private donors enabling that institution to carry out the Finsen treatment with remarkable success.

Finsen was a man of noble qualities, of high scientific attainments, and of a remarkably inventive mind. The construction of his apparatus is sufficient to indicate this. It was no chance discovery, but was laboriously built up by the adaptation of scientific principles. His modesty, quiet humour, and total absence of self-seeking brought him the esteem and affection of all who knew him.

Always a poor man, Finsen could with difficulty be persuaded to retain for the use of his family any part of the Nobel prize of 100,000 crowns which was awarded him. He wanted to give all to his institute, but eventually agreed that half should be placed at interest for his family, to revert subsequently to his great work. This institute and its beneficial cures are a fitting memorial of a splendid life of quiet heroism in the cause of science.

NOTES.

A CAREER of high promise was cut short by a lamentable accident at the "Devil's Kitchen," near Bethesda, North Wales, on September 20. Mr. Ronald William Henry Turnbull Hudson, lecturer in mathematics at the University of Liverpool, who, with Mr. J. F. Cameron, lecturer of Caius College, Cambridge, was climbing a difficult *couloir*, dislodged a mass of rock, and, falling with it, was instantly killed. Mr. Hudson, who was just twenty-eight years of age, was the son of Prof. W. H. H. Hudson, of King's College, London, and the brother of two sisters who recently distinguished themselves in mathematics at Newnham College. He was educated at St. Paul's School and St. John's College, Cambridge. He gained every college award that was open to him, and graduated as senior wrangler in 1898, his friend Mr. Cameron being second wrangler. The two comrades were alone in the first division of the first class in part ii. of the tripos in 1899, and in the following year each was a Smith's prizeman. In 1900 Mr. Hudson was elected a fellow of his college, and engaged with success in teaching and research. He graduated M.A. in 1902, and was appointed lecturer at Liverpool, where his powers rapidly matured. He published a number of papers, chiefly on analytical and geometrical subjects, which manifested much freshness and skill, as well as width of interest and of knowledge. He was unusually well read in classical and modern literature, and in experimental science. In athletic pursuits he was also keenly interested, and more than once steered his college boat to victory. It was confidently expected that ere long he would be promoted to a professorial chair, for which his gifts and acquirements specially fitted him. The news of his untimely death was received in Cambridge with the deepest regret, and with sincere sympathy for his family and college.

THE fifth annual Huxley memorial lecture of the Anthropological Institute will be delivered on Friday, October 7, in the theatre of the Civil Service Commission, Burlington Gardens, when Dr. J. Deniker, of Paris, will lecture on the different racial elements in the present population of Europe.

THE King has conferred the title "Royal" upon the Edinburgh Museum of Science and Art, and approved its designation being altered to "The Royal Scottish Museum."

EXTENSIONS made to Millport Marine Biological Station, including new laboratory, research rooms, tank-room, and library, all the gift of Mr. James Coats, jun., of Paisley, were opened on Tuesday by Sir John Primrose, Lord Provost of Glasgow.

THE Liverpool School of Tropical Medicine proposes to dispatch a second expedition to the Amazon in view of the necessity of further investigation of yellow fever. The expedition will probably start at the end of this year.

THE National Association for the Feeble-minded and the National Union of Special School Teachers have arranged a conference to be held at the Guildhall on October 13 and 14 to discuss various aspects of physically, mentally, and morally defective children.

REUTER'S correspondent at Naples states that the Vesuvius Observatory has issued the following notice:—"The activity of Vesuvius is very great. The walls of the crater, which have collapsed, tend to obstruct the bottom of the crater, whence proceed immense explosions and volcanic dust. The torrent of lava in the valley of Atrio del Cavallo is forming small volcanoes, the explosions from which attain a height of 150 metres. Large fissures have occurred in the great cone, the rupture of which is considered possible." The eruption of Mount Vesuvius on September 23 is said to have been the greatest within the last ten years. On September 25 explosions were frequent, and masses of igneous matter were hurled to great heights. Parts of the neighbouring woods have been burned, the funicular railway has been damaged, and the guides' quarters have been destroyed.

The following papers will be read at the autumn meeting of the Iron and Steel Institute to be held in New York on October 24 and 26:—Iron and steel at the St. Louis Exposition: Prof. H. Bauerman; a West African smelting-house: C. V. Bellamy and F. W. Harbord; the influence of carbon and phosphorus upon the strength of iron and steel: H. H. Campbell; the Rateau low-pressure turbine at steel-works and collieries: E. Demenge; a dry air blast apparatus: J. Gayley; high-speed tool-steels: J. M. Gledhill; the determination of carbon and phosphorus in steel: Baron H. Jüptner von Jonstorff, A. A. Blair, G. Dillner, and J. E. Stead, F.R.S.; acid open hearth manipulation: Andrew McWilliam and W. H. Hatfield; a power gas plant for Johannesburg: P. J. Mallmann.

The fourth general meeting of the International Fire Service Council was recently held at Budapest on the occasion of the International Fire Congress, which was organised under its auspices. The meeting was presided over by M. G. de Marie, of Luxemburg. All the European countries were represented, with the exception of Portugal, Turkey, and the Balkan States. It was decided that the seat of the council remain at Luxemburg for the next four years. Mr. Edwin O. Sachs, chairman of the British Fire Prevention Committee, was re-elected vice-president for the impending four years. The work of the council for this period will deal to a considerable extent with technical questions, with statistical questions in respect to fire losses, and with the preparation of a fire technical dictionary in the German, French, and English languages. The next general meeting of the council will be held at Milan in 1906. Among the resolutions adopted by the recent conference at Budapest were the following:—(1) That it is absolutely essential that all stage scenery and properties be rendered non-inflammable in a trustworthy and permanent manner, and that all the constructional parts of a stage be of a fire-resisting character. (2) That the greatest attention should be accorded to the chemistry of fire protection in the interests of fire prevention.

The twelfth annual report of the Sonnblick Society for the year 1903 contains a very interesting description by Dr. O. Szlavik, an assistant at the Vienna Meteorological Office, of a winter passed by two observers and himself on the summit of that mountain, at an altitude of 10,190 feet above the sea. For various reasons, including the want of educated companions and the difficulties of locomotion, Dr. Szlavik considers that a winter passed at such a station compares unfavourably with the privations endured at a Polar station. The meteorological summary for 1903 shows that the mean monthly temperature only rose above the freezing point in the month of August. The maximum (46°·8) occurred in September, and the minimum (−14°·4) in February. Snow or rain fell on 205 days. The pamphlet also contains an illustrated article on optical phenomena observed at the station, the results of observations at several high-level stations in the neighbourhood of the Sonnblick, and other useful information relating to mountain meteorology. We are glad to learn that the society has decided to combine the results of the last twelve years in one handy volume.

The *Journal* of the Sanitary Institute for August (xxv., part ii.) contains the addresses delivered to the congress of the Sanitary Institute at Glasgow, and Sir Douglas Powell's lecture to the congress on "The Prevention of Consumption."

We have received the September number of *Our Hospitals and Charities*, an illustrated monthly journal which gives interesting particulars of the various London and provincial hospitals, convalescent homes, and other charitable institutions.

Several papers have recently been published on the morphology and occurrence of the Leishman-Donovan body or parasite (see Nature, lxix. pp. 167 and 495, and lxx. p. 85). This parasite occurs in certain cases of irregular tropical fever of long duration, associated with enlarged spleen and marked cachexia. Major Donovan, I.M.S., in the *Lancet* (September 10, p. 744) describes fully the cases in which he has detected the parasite, and gives a number of coloured drawings of the latter. In the *British Medical Journal* (September 17, p. 642) the discussion on this parasite at the meeting of the British Medical Association is reported. Major Leishman, R.A.M.C., in opening it, stated that he had expressed the opinion that this parasite was a stage in the life-cycle of a flagellate protozoon, probably a trypanosome. Prof. Leonard Rogers described experiments he had performed on the cultivation of the organism, and stated that undoubted trypanosomes had appeared in two of his cultures.

The report of the departmental committee appointed to investigate experimentally and to report upon certain questions connected with the dipping and treatment of sheep has recently been issued. The composition of efficient dips, their method of use, and their effects upon the animals, the wool, and the parasites for which they are employed, and the life-history of the sheep-scab acarus and other parasites, are some of the subjects dealt with, and a series of recommendations is given for the periodical dipping of sheep. All the dips tested proved efficient; they consisted of arsenic and alkali, arsenic and sulphur, preparations of tar, tobacco and sulphur, and carbolic acid. The tobacco and sulphur preparations seemed to be the most active, rapidly killing the parasites, and having no injurious action on the wool; they are, however, somewhat costly. The arsenical preparations have to be used with care, or the animals may suffer. Some of the tar preparations had a deleterious action on the wool.

In the *Bulletin* of the Johns Hopkins Hospital for July (xv., Nos. 160–161), Dr. Harvey Cushing surveys the sensory distribution of the fifth cranial nerve, Dr. Percy Dawson continues his biography of the Rev. Stephen Hales, and Dr. Schmoll discusses the chemical origin of leucocytes. In the last named the question is discussed whether the organism is able to synthesise the nuclein of its tissue cells, or is obliged to build them out of the cell material contained in its food. From a study of cases of leucæmia, and the influence on the leucocytes of ordinary mixed diet and of a purin-free diet, the conclusion is arrived at that, while the organism prefers to draw upon preformed nuclein material, it is perfectly able to synthesise this if necessary.

Dragon-fly "nymphs" form the subject of a paper by Mr. J. G. Needham published in the *Proceedings* of the U.S. National Museum (No. 1371). The examination of a large series of the immature stages of these insects has tended to throw light on the mutual relationships of the forms to which they severally belong.

Considerable interest attaches to an article by Messrs. Castellani and Willey in the August issue of *Spolia Zeylanica* on the parasites found in the blood of vertebrates in Ceylon. The only trypanosome detected by the authors in the island is *Trypanosoma lewisi*, which infests at least 25 per cent. of the rats in millions, but without doing any appreciable harm to its hosts. Although the trypanosome

of cattle disease can be readily transmitted by inoculation into rats, the rat-parasite will only develop in its proper hosts. Some curious problems in development are presented by the life-history of a gregarine found in the blood of a water-snake.

In the September issue of the *American Journal of Science* Mr. E. H. Sellards continues his account of the Palæozoic cockroaches, with descriptions of several new Coal-measure types. Another article, by Mr. G. R. Wieland, is devoted to the structure of the turtles of the genus Lytoloma, as exemplified by specimens from the Upper Cretaceous of New Jersey. These turtles, it may be mentioned, are characterised by the backward position of the inner nostrils and the great length of the mandibular symphysis. The author considers that they were specialised for the purpose of feeding on shell-fish, and confirms Mr. Lydekker's reference of the English Eocene *Chelone planimentum* to the American genus

Drs. B. L. Robinson and J. M. Greenman continue to publish the results of their examination of Mexican and Central American plants in the first number of the current volume of the *Proceedings* of the American Academy of Arts and Sciences. Mr. M. L. Fernald presents a synopsis of species of Alnus, and describes a number of new species from the same countries.

It is tolerably well known that contact with certain plants, notably species of Rhus and Primula, often causes inflammation. This may be described as a form of eczema, or in some cases would be more correctly called dermatitis. Mr. J. H. Maiden has made these plants the subject of a short paper which he laid before the Therapeutical Society in March, 1903.

Since the first description with figures of Melocanna by Roxburgh in 1819, it was known that this genus of bamboos growing in eastern Bengal and Burmah was characterised by the production of a succulent fruit about the size of a pear, and containing one large oval seed; later it was observed that germination started before the fruit was shed. Only recently has a complete description been forthcoming in the paper which Dr. O. Stapf communicated to the Linnean Society, and which is published in the *Transactions* (June). The fruit of Melocanna differs from that of ordinary grasses in other respects, because the ripe seed contains no endosperm, the food being stored up in the pericarp, and the collapsed endosperm cells act as a diaphragm. One of the most striking features of the plant is that it forms large jungles or forests, in which after many years of vegetative growth all the plants produce their flowers and fruits simultaneously.

In view of the discussion of electrical units by the International Electrical Congress at St. Louis, the Physikalisch-Technische Reichsanstalt publishes in part xxxi. of the *Elektrotechnische Zeitschrift* a protest against defining the unit of electromotive force by reference to a standard cell. It is maintained that sufficiently large differences exist in the E.M.F. of any one type of cell with differences in constructional detail to prevent the adoption of such a unit from giving satisfaction. With our present knowledge of standard cells, it is contended, the unit of resistance should be the mercury unit, and current should be defined by reference to the silver voltameter; the unit of E.M.F. is then the derived unit obtained by assuming Ohm's law.

We have received from the author a reprint of a paper read before the German Physical Society by Mr. L. Austin on the alteration in length during magnetisation of Heusler's magnetic alloys of manganese, aluminium, and copper. It contains a description of a very simple apparatus for measuring minute changes in length, in which the magnifying principle adopted is the reflection of a beam of light from a plane mirror. Besides showing that the alloys increase in length during magnetisation proportionally to the magnetic force, the author describes a peculiar contraction which they subsequently undergo when exposed to a magnetic field of constant strength. The contraction seems to be roughly proportional to the square of the magnetic intensity.

In No. 18 of the *Physikalische Zeitschrift* Prof. F. Paschen publishes an experimental investigation of the γ rays emitted by radium. These extremely penetrating radiations have hitherto been regarded as most closely allied to the Röntgen rays, but as they carry with them a negative charge which they are capable of imparting to substances that they encounter, it appears more justifiable to regard them as a species of kathode rays. All attempts, however, to deflect the γ radiations in the same way as the β rays by means of an intense magnetic field were unsuccessful. Even in a field of 30,000 C.G.S. units a perceptible deviation from a straight line path could not be detected. By carefully measuring the thermal effect of the γ radiations, the surprising result was obtained that the energy of a γ electron must be at least 3200 times greater than that of a β electron. That the γ rays cannot be the Röntgen effect of the β or kathode rays of radium is shown by the fact that their total energy is to that of the β rays in the ratio 74 : 1. It is concluded, indeed, that the γ rays carry with them the greater proportion of the energy of radium.

An improved means of observing the beautiful scintillations exhibited by a sensitive screen under the action of Alpha rays has been devised by Mr. F. H. Glew, 156 Clapham Road, S.W. The little instrument, which is called the "Scintilloscope," consists of a simple magnifier of adjustable focus, as in the spinthariscope, but instead of the fixed screen and particle of radio-active substance a small double plate of glass is used. One of these pieces of glass is coated with a radio-active salt, and the other is a radio-sensitive screen. Upon looking at a combination of this kind with the lens the sparkling appearance is very clearly seen. The advantage of this method of observing the effect is that different combinations of radio-active substances and screens can be used. For instance, a sensitive screen placed upon a piece of pitchblende ground flat and polished shows the scintillations very well. Mr. Glew's device provides an effective way of exhibiting the brilliant display produced by radio-activity on sensitive screens.

In the *Proceedings* of the American Philosophical Society (vol. xliii. p. 123) Messrs. Edgar F. Smith and F. F. Exner give an account of an elaborate investigation of the atomic weight of tungsten. The authors, on the basis of a critical examination of previous determinations, consider it doubtful whether pure substances have been employed. The mean atomic weight calculated from concordant data obtained by converting the hexachloride into the oxide is 184·04, and by oxidation of the metal 184·065.

Some interesting results have been obtained by F. Garelli and F. Gorni in a study of the isomorphism of organic substances by the cryoscopic method. They are described in the August number of the *Gazzetta*. Substances may apparently differ very considerably in constitution, and yet crystallise together so as to form a solid solution. Thus, for example, phenyl benzoate, phenyl salicylate, and salicylhydroquinone, which differ by the

important hydroxyl group, readily form mixed crystals. That a definite law does not hold in such cases is shown by the fact that phenol and hydroquinone, which bear the same relation to each other as phenyl salicylate and salicylhydroquinone, are not perceptibly isomorphous. The results are of importance as indicating a limitation of the cryoscopic method of determining molecular weights.

SOME experiments which are of importance from the standpoint of the theory of dyeing are described in the *Proceedings* of the Vienna Academy of Sciences (No. 15) by Prof. W. Suida. On exposing several finely divided natural silicates to the action of coal-tar dyes, it was found that those silicates which were of an acid nature, containing free hydroxyl groups, were permanently dyed by the basic dyes of this series, whilst acid dyes were without action. Similarly, hydrated silicic acid readily absorbs the same colours, whilst silicic anhydride has no affinity for them. When kaolin is used, the different colour-bases combine with it in equivalent proportions, probably to form colour-salts, the original acid in the dye becoming attached to constituents of the clay. Similar results were obtained with potato-starch, and the general conclusion is drawn that the process of dyeing with basic colours is far more chemical than physical in its nature.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN OCTOBER :—

Oct. 1. 7h. Mercury at greatest elongation, 17° 54′ W.
5. 7h. 45m. to 9h. 7m. Transit of Jupiter's Sat. III.
7. 15h. Moon in conjunction with Mercury. Mercury 1° 1′ N.
12. 11h. 0m. to 12h. 24m. Transit of Jupiter's Sat. III.
15. Venus. Illuminated portion of disc = 0·897, of Mars = 0·956.
18. 11h. 0m. Jupiter in opposition to the Sun.
19. 14h. 13m. to 15h. 42m. Transit of Jupiter's Sat. III.
19–21. Epoch of October meteors (Radiant $92° + 15°$).
19. 10h. 8m. Minimum of Algol (β Persei).
22. 6h. 57m. Minimum of Algol (β Persei).
23. 10h. 0m. Moon in conjunction with Jupiter. Jupiter 1° 34′ N.
25. 6h. 37m. Jupiter's Sat. IV. in superior geocentric conjunction.
26. 16h. 48m. to 17h. 25m. Moon occults γ Tauri (mag. 3·9).

EXPLANATION OF THE MARTIAN AND LUNAR CANALS.—Prof. W. H. Pickering, writing to No. 7, vol. xii., of *Popular Astronomy*, offers an explanation of the formation and variation of the Martian canals which is based on their analogy to the similar features seen on the lunar surface. Whilst accepting the vegetal origin so ably supported by Mr. Lowell, Prof. Pickering finds the theory of artificial pumping suggested by that observer difficult to realise.

Instead of this, he supposes that the lunar canals, and hence, by analogy, those observed on Mars, are simply lines of volcanic action on the surface where the crust is weakened, and therefore is easily cracked by the internal stresses put upon it by the action of the heated interior.

This theory is supported by his observations that the canals, and also the lakes from which they appear to radiate, are dotted by small craterlets and are so symmetrically arranged about the craterlets as to suggest a causal relation between the two phenomena. Analogous formations are common in terrestrial volcanic districts; for example, in the 2000 mile stretch of volcanoes which occurs in the Andes.

This theory does not require the transference of water and carbon dioxide along the canals, but supposes that they issue directly from the interior along the whole length of each fissure, and in conjunction with sunlight promote the growth of vegetation. Owing to the rarity of the atmosphere, Prof. Pickering suggests that the vapours would not ascend on their emergence, but would quietly roll down the slopes of the craterlets, or "lakes," and canals, thereby sufficiently irrigating the immediate vicinity to produce the vegetation.

FURTHER OBSERVATIONS OF THE RECENT PERSEID SHOWER.—Communications from American observers confirm the comparative richness of the recent display of Perseids.

At Wilmington (N.C.) Mr. E. S. Martin saw between 25 and 30 Perseids per hour between 9 p.m. and 12 p.m. (local M.T.) on the nights of August 10 and 11, although very few were seen on August 12 and 13, and none on August 14.

At Barre (N.Y.) Mr. W. Wetherbee saw 154 meteors, of which 116 were Perseids, in less than three hours on the eve of August 11. He remarked that many of the Perseids appeared in pairs the components of which travelled in parallel paths and had equal magnitudes. According to this observer, the radiant has moved westward, and appeared to be near to the star ι Persei. One extraordinarily bright Perseid appeared in Aquila, and left a trail 10° long which lasted for about four minutes (*Popular Astronomy*, No. 7, vol. xii.).

POSITION OF SATURN'S NINTH SATELLITE.—A telegram from Prof. E. C. Pickering, published in No. 3969 of the *Astronomische Nachrichten*, announces that Prof. Barnard observed Phœbe, Saturn's ninth satellite, on September 12·6916 (G.M.T.). The apparent position at that time was as follows :—

$$\alpha = 21\text{h. } 12\text{m. } 29{\cdot}5\text{s.}, \quad \delta = -17° \ 25' \ 55''.$$

The motion of the satellite was south-west, whilst the magnitude was 16·7.

DISTRIBUTION OF NEBULÆ IN RELATION TO THE GALAXY.—In No. 3969 of the *Astronomische Nachrichten* Dr. C. Easton discusses the distribution of the nebulæ in regard to the galactic system.

Commencing with the usually accepted statement that the nebulæ not only occur some distance from the Milky Way, but that they actually tend to congregate about the galactic poles, he confirms this, from observational data, for the northern hemisphere, but questions its truth for the southern hemisphere. He further states that the accepted notion that it is simply the lack of observations which accounts for the apparent scarcity of nebulæ in the southern hemisphere is not founded on fact. If it were true, then that part of the northern galactic zone which lies south of the equator should apparently contain fewer nebulæ than that part which is above, because it has not been so well observed. The following figures show that although this is true for the faint nebulæ, which with the planetary nebulæ are placed in the category of "green nebulæ," in the case of the bright (*i.e.* "white") nebulæ the inverse is true :—

Northern Galactic Zone.

	A S. of the equator	B N. of the equator
Faint nebulæ	754	1043
Bright nebulæ	152	71

This leads to the conclusion that the nebulæ in the southern hemisphere are not arranged in the same manner as those in the northern.

Several other interesting points are developed by Dr. Easton in his paper, and are supported by the tabulated observational results which he gives. One other important conclusion at which he arrives is that the faint nebulæ are allied, as regards their phase of development, to the stellar conglomerations of the galaxy and occur in the same regions, whilst the bright (*i.e.* "true") nebulæ are similarly allied to the sparsely distributed non-galactic stars.

ASTRONOMY AND COSMICAL PHYSICS AT THE BRITISH ASSOCIATION.

GREAT vitality was shown in this subsection, and three mornings and one afternoon were hardly sufficient to get through the rather large programme. The meetings were well attended, and were of particular interest, since many distinguished foreigners were present, several of whom attended at Cambridge in consequence of the meeting there of the subcommittee of the International Meteorological Committee which was appointed at Southport last

year to discuss the means of advancing our knowledge of the relation between solar and terrestrial changes.

Sir John Eliot's address has already appeared in these columns, so that attention here will be restricted to the subsequent proceedings of the subsection.

With Sir John Eliot in the chair, the first paper on Friday was by Father Cortie, who summed up the results of all the observations of sun-spot spectra made at Stonyhurst during the period 1883–1901. One of the chief points of the paper was to show the great importance of the elements vanadium and titanium, the lines of these elements being more frequently widened than those of any other. Reference was also made to widened-line crossings and to oxygen in the spectra of sun-spots.

Sir Norman Lockyer then followed with a short summary of his work on the classification of stars according to their temperature since he gave the Rede lecture in 1871. The chief feature of the paper was to show that by paying special attention to the results obtained with a small camera having calcite and quartz to replace the glass lens and prism used in his earlier work, he was enabled to bring a more efficient check on the classification from the point of view of the extension of the spectrum in the ultra-violet than he could with the glass optical parts. The result of this inquiry confirmed the chemical classification in every respect.

The extension in the ultra-violet part of the spectrum as a criterion of stellar temperatures was the subject of a paper by Mr. H. F. Newall, who was inclined to question this criterion based upon the ultra-violet extension. He referred to observational evidence, which displayed sometimes perplexing discrepancies between the relative intensities of the blue and the red ends of the spectrum in different stars. The point raised was, how far was the present criterion of stellar temperature based upon the observed behaviour of gaseous radiation as opposed to the radiation of solid bodies? He said, in conclusion, that it was not impossible that we should be forced to regard extension in the ultra-violet regions as a sign of differences and not of high temperature.

The paper on the short-period barometric see-saw and its relation to rainfall, by the present writer, was an extension of a paper which has previously been printed in this Journal (vol. lxx. p. 177). The chief point was to show how very closely rainfall curves were associated with curves representing the inverted barometric changes. The regularity of the barometric see-saw mentioned above suggested that there may possibly be found to exist a method here of forecasting wet and dry years over a large portion of the earth's surface.

After a brief interval for lunch, the meeting was continued, Dr. Shaw taking the chair in the absence of Sir John Eliot.

Prof. Birkeland (Christiania) spoke about the relationship between sun-spots and auroræ. The chief feature was to indicate that "stream lines" from the sun could only reach the earth's atmosphere between very narrow limits, and these in high latitudes, and further that only spots on a restricted portion of the solar disc in relation to the position of the earth would have any terrestrial effect. In this way he suggested a means of explaining the narrow curtain-like form of the aurora and its occurrence chiefly in high latitudes.

A short paper by M. Angot (Paris) described a result which he had derived from an examination of Wolf's sun-spot numbers. He found that, by taking the relative number at a sun-spot minimum and also about a sun-spot maximum, small relative numbers at a minimum are followed by small numbers at a maximum, and large numbers at a minimum by large numbers at a maximum. As the last minimum (1901·7) was small, the next maximum, he suggested, will be small also. As another investigation points to the next maximum being comparatively large, it will be interesting to see which occurs.

The results of an investigation of the upper air over the Mediterranean by means of flying kites from a steamer were described by M. Teisserenc de Bort. He showed that although on the average greater elevation meant greater wind velocity, there were alternately strata of large and small velocities. This fact explains why sometimes attempts at getting kites to fly above certain elevations have failed. Both Mr. Rotch and Dr. Shaw spoke on this interesting question.

Commander Hepworth described the relation between pressure, temperature, and air circulation in the South Atlantic Ocean, the result of a large piece of research work in which 3300 ships' logs had been utilised. In the absence of Prof. K. Ångström, his two papers, on the ultra-violet absorption spectrum of ozone and the existence of that gas in the atmosphere, and an instrument for the measurement of the radiation from the earth, were taken as read, and the meeting closed for the day.

On Monday, the second day on which this subsection met, Sir J. Eliot being in the chair, the reports of the seismological and kites committees were briefly summarised by Dr. Milne and Dr. Shaw respectively.

Mr. A. L. Rotch (U.S.A.) described the results of the experiments he has been making with kites at the Blue Hill Observatory in order to determine the temperature of the air in cyclones and anticyclones. Sir David Gill spoke about an attempt he had made to state the problems in practical astronomy which press for solution. Among these he mentioned the apparent discordance between the value of the constant of aberration as derived from direct observation (20″·52) and that obtained by combining the measured value of the sun's parallax (8″·80) with the known velocity of light, which gives a value of the aberration constant (20″·48). The discussion in the paper confined itself to the means to be adopted for perfecting the determinations of the solar parallax, the constant of aberration, and the mass of the moon. Reference was also made to the variation of latitude, to the Lœwy-Comstock method for determining the aberration constant, to recent improvements in methods of meridian observation, and to the value of old series of observations.

Dr. W. N. Shaw opened the discussion on a memorandum adopted by the committee of the council on the suggested uniformity of units for meteorological observations and measurements. Several speakers gave their views on the subject, but no definite conclusion was arrived at. The general opinion seems to be that either to alter or put additional scales to the barometers and thermometers would, from a practical point of view, be detrimental to the observations themselves. It was suggested that such units might be adopted in the discussion of meteorological problems, the conversions to the new scales being made after the observations had been collected at the central office. From the physical standpoint the subject was not discussed.

In a paper on the masses of stars, Dr. H. N. Russell pointed out that the average mass of fifty-five binary stars is about three times that of the sun. Groups of stars with very different spectra, magnitudes, and proper motions have almost the same average mass. Thus it was concluded that stars vary much less in mass than in other characteristics.

The third and last meeting of this subsection took place on Wednesday, Sir John Eliot being in the chair. The first two items on the programme were the reports of committees on the Falmouth Observatory and on observations of Ben Nevis. In the absence of Prof. O. Backlund (St. Petersburg), his paper on some results of researches on the comet Encke was taken as read.

The writer described briefly the spectroheliograph recently erected at the Solar Physics Observatory, South Kensington. This instrument, which is now in fair adjustment, is used for photographing the sun in monochromatic light. The numerous photographs shown gave an idea of the efficiency of the instrument, and they are now being daily secured, weather permitting. Composite pictures in "K" light were shown, the "limb" and "disc" of the sun being taken on one plate. Many of the photographs showed rapid solar changes, one enormous prominence 192,000 miles in length increasing to 216,000 miles in five hours, its height changing from 55,000 miles to 60,000 miles simultaneously.

In a paper on the unsymmetrical distribution of rainfall about the path of a barometric depression, Dr. H. R. Mill showed that, for the British Isles, the area of heavy rainfall, in nine cases out of ten, lay on the left of the cyclone's path, and in advance of the centre. This relationship suggests that a more definite basis for forecasting heavy rains becomes available if it be possible to ascertain previously the path of the cyclone's centre.

Miss Hardcastle read Miss F. E. Cave's paper, which contained some further results she has obtained relative to

the application to meteorology of the theory of correlation. The two stations taken were Wilmington (North Carolina) and Halifax (Nova Scotia), distant from one another about 1000 miles. Allowing different intervals between the corresponding barometric observations, the magnitude of the correlation was found to vary with these intervals, being greatest when Halifax is taken one day later than Wilmington. It was suggested that for selected places further apart the discovery of correlations of sufficient magnitude might be of use in the practical work of prediction.

Major B. Baden-Powell described briefly the development of the aëroplane, and gave an account of the experiments that he has been recently carrying on. Chief among these were his gliding experiments made at the Crystal Palace, in which he is seeking to find out how a man-carrying machine behaves while travelling in the air.

After a paper by Prof. D'Arcy W. Thompson on Plato's theory of the planets, the business of the subsection came to a conclusion, the following papers being taken as read:— Report of Committee on Underground Temperatures; Dr. F. Hirtel, Zur Flugfrage; Rev. J. M. Bacon, upper air currents and their relation to the audibility of sound; Prof. Lemström (Helsingfors), on the effect of electric air-currents; J. Hopkinson, the rainfall of the midland and eastern counties of England, and the rainfall of England, 1861–1900.

WILLIAM J. S. LOCKYER.

ZOOLOGY AT THE BRITISH ASSOCIATION.

THE meetings of Section D were held in the new Sedgwick Museum of Geology. On Thursday morning, August 18, Mr. W. Bateson, F.R.S., delivered to a large audience his presidential address (see NATURE, August 25), the vote of thanks for which was moved by Prof. Poulton and seconded by Prof. Max Weber. In the afternoon Prof. F. W. Keeble gave an address, illustrated with diagrams and lantern slides, on the coloration of marine Crustacea, embodying results of the researches carried on by Dr. Gamble and himself during the last seven years. He described the prawn-like *Hippolyte varians* which lives among the seaweeds around our coasts, and matches their colour with marvellous precision. Its colours range through green, yellow, and brown to red. When given a choice between different coloured weeds, this animal invariably picks out for its abiding place that weed which is in harmony with its own coloration, a faculty to be ascribed not to the possession of a colour sense by the animal, but rather to an extreme sensitiveness to light. Only in one position, namely, on weed of its own colour, is it in a position of light equilibrium, and then it rests. The coloration of the animal is produced by the manipulation of its three colour pigments, red, yellow, and blue. The common shrimp and prawn were shown to possess the same mechanism, although they make little use of it. Transparent young Hippolytes placed on weed of a certain colour develop the pigment necessary to approximate the animals to that colour in forty-eight hours or less; older animals take almost a week for the same process, and adults a fortnight, but even then the result is imperfect. Though the adults have lost, to a large extent, this power of sympathetic colour change, the pigments react rapidly to changes of light. This reaction is most marked not when the intensity of light changes, but when the background on which the animal rests is changed from white to black, *i.e.* from one which scatters to one which absorbs light. In the daytime the pigments are expanded; at night they are contracted, except the blue, so that the animal has then a transparent azure colour. This is a true periodic change; it has become a habit, and endures for days even though the animals be kept in darkness.

Prof. W. B. Scott, of Princeton, U.S.A., then delivered an address (with lantern illustrations) on the Miocene ungulates of Patagonia The animals described were collected by the Princeton Expedition from the Santa Cruz beds, the Miocene age of which seems to be now established. Prof. Scott pointed out that while these South American ungulates are singularly different (especially in the structure of the periotic region) from those of the northern hemisphere, it is not unlikely that they have a common origin, as Ameghino has described a number of genera from pre-Patagonian formations which, though incompletely known, appear to be referable to the Condylarthra—the parent stock of the northern ungulates. Very probably an early Eocene or late Mesozoic migration carried the Condylarthra into South America, and there, in almost complete isolation, they gradually gave rise to the various peculiar orders of the Noto-Ungulata. The possibility of such a migration is shown by the discovery of an armadillo in the Middle Eocene of North America.

The section was occupied practically the whole of Friday, August 19, with papers and discussions on heredity, Prof. Hickson, F.R.S., in the chair.

The first paper was by Miss E. R. Saunders on heredity in stocks. She said that since the re-discovery of Mendel's work, experimental evidence of the purity of the germ cells has been found in a rapidly increasing number of examples. Much of this evidence has been derived from cases like those studied by Mendel where the differentiating characters are related to each other as dominant and recessive. In such cases the individuals of the (F_1) first generation (DR) show the dominant character, and those of the second (F_2) generation the two parental characters in the ratios 3 D : 1 R or 1 D : 1 R, according as they result from DR×DR or DR×R. In other cases the results are complicated by reversion, gametic coupling of distinct characters, &c., and they require careful analysis, and several generations may be required to elucidate them. As a surface character hoariness is dominant, glabrousness recessive. Experiments in the form DR×DR or DR×R, where D is the white-flowered form of *Matthiola incana* and R a glabrous ten-week strain, give normal Mendelian ratios in F_2. In other cases the result, as regards hoariness and glabrousness, is more complex, owing to the different behaviour of various glabrous strains, which, as far as can be seen, differ only in *flower colour*. As to flower colour, various combinations of colours give reversionary purple in the first generation (F_1). Purple F_1 may also be produced by two white parents if they belong to strains differentiated by the leaf surface. Such purple cross-breeds may give a simple Mendelian result in F_2, or a variety of new colour forms may appear, this latter being commonly seen when cream is one of the parental colours. For example, in a cross of a glabrous white with a glabrous cream, at least nine colour forms were produced in F_2. Whether the appearance of these new forms indicates disintegration or simply re-combination of preexisting characters is uncertain. Creams breed pure at once. Some whites are pure, others are heterozygotes with cream. The number of extracted recessive types resulting from a given union and their specific behaviours are not yet known.

Mr. A. D. Darbishire gave some account of his experiments on the breeding of mice. The Japanese waltzing mice show the well known restless and spinning movements; they have a piebald yellow and white coat and pink eyes. When an albino is crossed with a Japanese waltzing mouse the majority of the offspring are on first inspection indistinguishable from the common house mouse, and they invariably (in all the 300 cases bred) have black eyes. Hybrids never exhibit waltzing movements, and they are never albinos. When such hybrids are bred together they produce offspring which, considered from the point of view of colour, fall into three categories:—(1) those (half the number) with black eyes and coloured coat, and therefore resembling their parents; (2) those (one-fourth) with pink eyes and coloured coat, therefore presenting the same features of eye- and coat-colour as Japanese waltzers; (3) those (one-fourth) with pink eye and uncoloured coat, *i.e.* albinos. About one-quarter of these hybrids waltz, but the rest are normal in their progression, and the waltzing habit may be associated with any of the three colour categories. The albinos (group three) breed true, the pink-eyed mice with coloured coats breed nearly true, and the black-eyed mice with coloured coats produce, when paired together, albinos, pink-eyed mice with coloured coats, and black-eyed mice with coloured coats (proportions of each not yet determined). Some of the facts seem to confirm the Mendelian interpretation, while others may be described in terms of either Galton's or Pearson's formulæ of ancestral inheritance.

Mr. C. C. Hurst described some experiments on heredity in rabbits. An inbred pair of albino Angoras was crossed

reciprocally with an inbred pair of Belgian hares (F_1), and the hybrid progeny were bred with one another for two generations (F_2 and F_3). In F_1 the Angora coat was always recessive to the normal coat, and the albino character recessive to the normal character, while in F_2 and F_3 both these features followed the ordinary Mendelian rules. As to coat colour, in F_1 the first cross of brown and albino gave offspring all of which had wild grey coats. In F_2 the hybrid greys bred together gave a ratio of 9 grey : 3 black : 4 albino, which, when worked out in detail, is in accordance with the Mendelian expectation. Experiments on F_3 proved that the black factor was not introduced by the original brown parent, but by the albino, which, though gametically pure as regards simple albinism, was at the same time carrying the distinct factor for black coat colour.

Prof. Weldon, in opening the discussion, referred to one of Mendel's experiments in which he took a pea of a race producing only seeds with green cotyledons and crossed it with one of another race producing only seeds with yellow cotyledons. The resulting seeds produced plants a quarter of which bore green seeds only, a quarter yellow seeds only, and each of these sets was said to breed true. The remaining half produced seeds with the hybrid properties of their immediate cross-bred parents. Considering how reversion has been found by Mr. Galton in other cases, we might regard the hybrids which made up half the segregation generation as reverting directly to their parents, and the remaining half as reverting to the various green-seeded or yellow-seeded ancestors in various proportions, so that every generation of ancestry was represented to a greater or less extent, the nearer ancestors more frequently, the remoter more rarely. In Mr. Bateson's translation Mendel says that the yellow-seeded individuals reproduce the character of the yellow-seeded "parent form," but we do not know whether Mendel meant the race or one individual of the race. Mr. Bateson and others have adopted the view that, so far as colour is concerned, the green-seeded and the apparently true-breeding yellow-seeded forms were not merely like, but identical with the pure individuals of the green- or yellow-seeded races used in making the original cross. The view attributed to Mendel paid attention to the last two only of the pure-bred ancestors, while that of Galton and others considered that all the ancestors contributed in various proportions to the characters of the subsequent generations. The description of the seed colours is not accurate enough to enable one to decide between these two hypotheses. Because each human being, his parents and grandparents, have seven cervical vertebræ, we have no right to say that we are exactly like our fathers, and that our grandfathers have no share in determining our characters. Again, each of the species included as *Lychnis dioica* has a hairy and glabrous form, the plants resulting from a cross of which are hairy, and the offspring of such hybrids are hairy or glabrous in Mendelian proportions. But we are not told how hairy either plant is. Prof. Weldon counted the hairs on pure-bred hairy plants, and found them to vary from about a dozen to 1300 per sq. cm. of leaf surface. Now if one with 1300 hairs per sq. cm. were crossed with a glabrous plant, and if the offspring had on an average 500 hairs per sq. cm., were they "hairy" like their hairy parent or completely intermediate between the two parents? Questions of this kind required finer methods of observation and description. Again, the frequent existence of reversions to the characters of fairly remote ancestors was inconsistent with the idea that the characters of hybrids might be regarded as due to the combination of "pure" determinants derived from their immediate parents. It had been said that the numerical conclusions drawn from the Mendelian hypothesis agreed so closely with the observed distribution of the descendants of hybrid individuals that these alone justified the conception of gametic purity. It was easy with a small series of results to devise several hypotheses which would fit the results. For example, crossing albino and yellow mice of known ancestry, Cuénot obtained 81 albino, 34 yellow, 20 black, and 10 grey mice, and the remarkable modification of Mendel's theory which he had put forward to describe this result led him to predict the numbers 76, 38, 19, and 19. This was not so good as Prof. Pearson's prediction—82·5, 31, 20·5, 17. In conclusion, he argued that until further experiments and more careful descriptions of results were available, it was better to use the purely descriptive statements of Galton and Pearson than to invoke the cumbrous and undemonstrable gametic mechanism on which Mendel's hypothesis rested.

In the afternoon of August 19 Mr. Punnett, on behalf of Mr. Bateson, described the effects of crossing in fowls, and Prof. Minot added some observations on his experiments upon guinea-pigs.

Mr. Bateson then replied in some detail to Prof. Weldon's criticisms, and maintained that by the Mendelian hypothesis alone was it possible to draw together the vast number of observed facts which had seemed utterly incoherent. The Ancestrians, however, asserted that the laws based on ancestry could cope with the same facts. Prof. Weldon had passed very lightly over the critical fact which finally settled the question—the purity of the characters of the segregated types. None of the various schemes of the Ancestrians had contemplated such purity, and all were totally unable to deal with it. The last attempt to explain away the fact of purity of type was that enunciated to-day by Prof. Weldon, who regarded it as "reversion." But if the "reversion" were so complete as to include even the purity of the parental type, such reversion was Mendelian segregation by another name. The second fact with which the Ancestrians could not deal was the condition of those hybrids or heterozygotes which, though again and again crossed back with pure types, had always the same gametic constitution undiluted. He illustrated this from the work of Mr. R. H. Lock on maize, in which it was shown that, using mongrel materials, as regards yellow and white grains, the inheritance was of a normal Mendelian order. Sweet peas provided further illustrations of the applicability of Mendelian principles to complex cases. It was shown that, in one example, at least eight kinds of purple individuals occur in the second generation, each having distinct powers of transmission, though outwardly indistinguishable. Only minute experiment could distinguish these fundamental differences, which the biometrical system entirely disregarded. The evidence also included one significant case in which sterility of the anthers behaved as a Mendelian character, and made it possible to discriminate two types of extracted whites almost certainly dissimilar in their powers of transmitting colour-factors. Prof. Weldon had asked whether the extracted types showed parental characters unchanged. Frequently the extracted types were identical with the pure, but the question must be answered case by case, according to the special sort of segregation which took place in each case. The Mendelian theory had begun to coordinate the facts of heredity, until then utterly incoherent and contradictory. The advance made in five years had been enormous, and he had no doubt of the result.

Prof. Karl Pearson said that the great revolution which Mr. Francis Galton introduced into biological study was purely a difference of method. The introduction of methods of precision had nothing to do with Mendelism or ancestral law. He had seen the Mendelians produce figures without making any attempt to show that the figures were consonant with the theory they were supposed to illustrate. He believed he had elaborated the most complete Mendelian system ever yet worked out, but this led to general principles which were singularly like those proposed by Galton from observation. He asked from the Mendelians some definite theory which could be worked out, and for further work, for the controversy could only be settled by investigation, not by disputation.

After some remarks by Prof. Hubrecht and Rev. T. R. R. Stebbing, who said that interest in this important inquiry was greatly quickened by the controversy, and hoped it would continue, as from it the world could only gain the light, Prof. Hickson (from the chair) closed the discussion by saying that the subject in dispute was of the greatest importance, and the debate had been of much value to those biologists who were still "sitting on the fence."

In the zoological laboratory there were numerous exhibits of the specimens used in these various experiments on heredity.

At the invitation of His Grace the Duke of Bedford, a party of twenty-five zoologists visited Woburn Abbey on Saturday morning, August 20. The party was met by two representatives of the Duke of Bedford, and driven over the estate to see the splendid collection of animals there maintained in such excellent condition. Numerous species of

deer, the nilgai, gnu, eland, buffaloes and European bison, giraffes, and a fine series of Prjevalsky's horse were greatly admired. Mr. R. Lydekker (the leader of the party) and Prof. Ewart pointed out the interesting features of the rarer forms. The party was afterwards entertained to lunch, and conducted through the picture galleries of the abbey.

On Monday morning, August 22, Dr. C. W. Andrews gave an address on Egyptian Eocene vertebrates and their relationships, particularly with regard to the geographical distribution of allied forms.

Prof. Keibel, of Freiburg, exhibited some "Normentafeln" of the development of Vertebrata, and also some original drawings of embryos of apes. He stated that although there is a close resemblance between these and human embryos in a similar stage (as Selenka has shown), there are found on further examination various differences—apart from the tail—not only between human and Simian embryos, but also between those of different species of apes, so that the species may be determined without difficulty in embryos from the fourth to the fifth weeks.

Then followed communications by Mr. A. E. Shipley, F.R.S. (on behalf of Dr. Elliot Smith), on Looss's researches on *Ankylostoma duodenale* (miner's worm); by Prof. G. N. Calkins on *Cytoryctes variolae*, Guarnieri, the organism of small-pox; and by Dr. J. A. Murray on the biological significance of certain aspects of the general pathology of cancer (for abstracts see NATURE, September 22, p. 519).

Dr. T. H. Bryce demonstrated a series of slides illustrating the histogenesis of the blood of the larva of Lepidosiren.

Mr. J. W. Jenkinson gave an account of the origin of the cleavage centrosomes in the egg of Axolotl. The middle piece of the spermatozoon, after forming the centre of the sperm-sphere and sperm-aster, completely disappears. At a later stage a centrosome is formed from the sperm-nucleus, and this divides to give rise to the cleavage centrosomes. A watery substance collects in vacuoles in the centre of the sperm-sphere, which suggests that the sperm introduces into the ovum a hygroscopic substance.

Four papers from the Irish Fisheries Laboratory were then read by Mr. Tattersall.

Messrs. E. W. L. Holt and W. M. Tattersall described some new and rare Schizopoda from the Atlantic slope on the west of Ireland, Mr. Tattersall some Isopoda, and Mr. G. P. Farran some Copepoda from the same region. Many of the Isopoda and Copepoda collected appear to be identical with, or closely allied to, Norwegian forms. Mr. Tattersall also gave a brief account of a new species of Dolichoglossus. It was found in Ballmakill Harbour, co. Galway, in coarse sand and mud at extreme low water spring tides, eight to twelve inches below the surface, in tubes of sand cemented by mucus. A nearly complete specimen measured 12·5 cm. Its chief points of interest are two proboscis pores, complete and continuous lumen of stomochord, and the great size of the pericardium.

The proceedings on Tuesday morning, August 23, were opened by Prof. Graham Kerr's account of the work of the late Mr. J. S. Budgett on the development of Polypterus. A series of lantern slides, most of which had been prepared from Mr. Budgett's drawings, showed that as regards external characters the development was very like that of an amphibian. There is a pair of true external gills and a pair of cement organs. Dr. Harmer and Prof. Bashford Dean spoke in appreciative terms of Mr. Budgett's work.

Mr. E. J. Bles contributed some notes on the development of *Phyllomedusa hypochondrialis*, Cope. The material described was obtained by Mr. Budgett in South America. Just before hatching paired cement organs are present as vestigial structures, but soon disappear without having become functional. This indicates that Phyllomedusa is probably descended from a form which, like our European Hyla, was hatched as a heavily yolked larva which hung from its cement organ until the yolk was absorbed. The amount of yolk in the egg of Phyllomedusa (which is now large) has probably only comparatively recently increased. There is also a glandular frontal organ in Phyllomedusa probably of use in assisting the embryo to escape from the egg-membranes. The thyroid gland in Phyllomedusa differs from that of other tadpoles, and is more like the early thyroid of Ammocœtes, as it reaches along the whole length of the floor of the buccal cavity. The subnotochordal rod is also conspicuous. The pectoral lymph-hearts in this, as in other tadpoles, appear not at the metamorphosis, but when the tadpole has still a solid intestine and the yolk has almost disappeared from all the other tissues. The wall of the lymph-heart appears to be derived from an outgrowth of the posterior cardinal vein, and before the valves are formed the lumen of the lymph-heart contains blood corpuscles.

Prof. C. S. Minot then communicated three papers. In the first he presented the theory of cellular rejuvenation, which he claimed must be defined as the increase of the nuclear substance in proportion to the amount of the protoplasm. This increase occurs during the period of segmentation of the ovum, is the immediate result of impregnation, and results in the production of rejuvenated cells, *i.e.* cells with a very small amount of protoplasm around their nuclei. These cells and their descendants then enter upon a career of cellular senescence. In an experiment with telegony Prof. Minot used females of a known race the virgin does of which were allowed to breed with a male of entirely different strain, about half the offspring having the paternal colour. The same does were afterwards allowed to breed with bucks of their own race, and in no case was there any trace of the colour of the telegonous father in the offspring. Prof. Minot gave an account of the Harvard embryological collection, which comprises more than 800 series of sections of vertebrate embryos, and pointed out its value in aiding research.

Dr. G. H. F. Nuttall, F.R.S., gave a paper on the precipitin tests in the study of animal relationships. He briefly described the methods of testing by means of precipitating antisera, and pointed out two practical applications of the test—in legal medicine for the identification of blood stains, and in the study of animal relationships. For example, this method has demonstrated a close relationship between Hominidæ and Simiidæ, a more distant one between these and Cercopithecidæ, a slight bond connecting all of these with the New World monkeys. The lemurs do not appear to be connected with the Primates any more than do other mammals. The test appears to connect the Cetacea with the Ungulata, and the Reptilia with the Aves.

In reply to a question by Prof. Poulton, Dr. Nuttall stated that tests of the blood of Echidna do not indicate any relationship between this animal and other mammals.

Prof. E. B. Poulton, F.R.S., gave a paper on the mimetic resemblance of Diptera to Hymenoptera, to which Lord Avebury, Mr. Bateson, and Mr. O. Latter added further observations.

In the afternoon of August 23 three addresses dealing with the evolution of the horse were delivered by Profs. Osborn, Ewart, and Ridgeway (for abstracts see NATURE, September 22, p. 520).

On Wednesday morning, August 24, Mr. J. W. Jenkinson gave an account of the effects produced by growing frog-embryos in salt and other solutions. The object of the experiments was to discover whether the distortion of development produced by growing the eggs of the frog in a 0·625 per cent. solution of sodium chloride is due to the physical (increased osmotic pressure) or chemical properties of the solution or both. The monstrosity consists of (1) failure of the blastopore to close, so that a large persistent yolk-plug is produced, and (2) the failure, total or partial, of the medullary folds to close. Solutions of chlorides or bromides of barium, calcium, &c., cause death of the egg at an early stage, possibly due to the formation of insoluble carbonates in the cells. When kept in chlorides or bromides of potassium, lithium, &c., the egg loses its power of elongating in the direction of the long axis of the embryo, but differentiation of the germ-layers and organs proceeds; ultimately degeneration and disintegration of the tissues set in. In sodium or magnesium chlorides or nitrates the embryo is able to elongate, but development is abnormal. In solutions of urea or sodium sulphate development is nearly or quite normal, especially in the latter solution, in which the tadpoles will live for weeks. Mr. Jenkinson thinks the various phenomena are to be attributed to the poisonous properties of the substances employed.

Prof. M. M. Hartog showed lantern slides of magnetic models of cellular fields of force. He remarked that there is in the dividing cell a dumb-bell-shaped structure recalling the figure of the "field of force" manifested by sprinkling

a sheet of paper, overlying two poles of a magnet, with magnetic dust. He showed photographs of various "fields" obtained by a combination of electromagnets, and pointed out that all the cellular phenomena could be reproduced by the action of a polar or dual force such as statical electricity or magnetism, and that the apparent anomalies were due to the peculiar conditions of the protoplasm in which the field was formed. He also showed some beautiful sections of the embryos of Rhynchelmis, lent by Prof. Vejdowsky, of Prague, in which the dumb-bell-shaped figure is of exceptional size.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

As the exploration of the higher mountain areas has been mainly the work of university men, it was very appropriate that Mr. Douglas Freshfield, one of the pioneers of Alpine exploration, should be president of the geographical section at Cambridge. No one was better qualified than he to deal with mountains and mankind, which formed the subject of his address, which has already appeared in NATURE (September 1).

Several other communications dealt with the "culminating area" of the globe, as Hermann Wagner calls it. Mr. Maurice de Déchy contributed a full account of the glaciers of the Caucasus, which at one time were supposed to be of very small dimensions. He gave statistics of the altitude of the snow-level in different parts of the system, showing how it rose towards the Caspian, and of the dimensions of the principal glaciers, including the depth to which their tongues descended below the snow-level. He then surveyed the variations of ice movements during the past half century, and pointed out how they corresponded with those which have been observed in the Alps. Finally, he referred to the evidences of the former great extension of the glaciers. Mr. Charles Rabot, secretary of the Paris Geographical Society and of the French Glacial Commission, discussed the importance of glacier-bursts in shaping the topography of glaciated areas. These bursts are due to the creation and subsequent sudden discharge of a reservoir of water, by a glacier dam due to the ice stopping the exit from a valley and the consequent accumulation of water, or to water gathering above, below, or in the glacier itself. The violence of the outburst is proportional to the volume of the water and the slope of the ground. In 1878 the Märjelensee discharged 7,700,000 cubic metres in nine hours, and the Gietroz outburst of 1818 attained a volume of 530,000,000 cubic feet. Twenty-five such outbursts are known to have taken place in the Alps, and they have been reported from all glaciated mountain areas. Their effects are necessarily confined to modifying the contours of the valley, by enormous erosion above, and by the deposition of vast masses of waste below. In discussing glacial phenomena, sufficient importance has probably not been given to these torrential outbursts, which must have been commoner in Pleistocene times. Mr. A. W. Andrews showed a number of excellent maps and views of passes of the Alps in order to prove that in teaching a well chosen set of lantern slides could be used to bring out their characteristic natural features, and to indicate their relation to routes, &c.

There was no tale of startling adventure recounted, but a number of excellent travel papers was read. Mr. Bruce's account of the Scottish National Antarctic Expedition, while barren in hair-breadth escapes, was one of steady scientific investigation under very difficult conditions in perhaps the most interesting area of the Antarctic. Notable though the discovery of the northern Atlantic margin of Antarctica and the depths of the ocean to the north are, the oceanographic, biological, and more particularly the meteorological work of the expedition are likely to yield results of the greatest value. It is a matter of congratulation that Mr. Mossman, probably one of the best living meteorological observers, remains in the south with the cooperation of the Argentine Government, for there the study of meteorological conditions is more important than elsewhere in high southern latitudes in view of the dangers attending the rounding of Cape Horn, and the importance of an investigation of the centres of atmospheric activity controlling its meteorology.

The papers dealing with distant lands described the low-lying Malabar coasts, the savanna lands of northern Nigeria, the fertile Cyrenaica, and the puna of the Andine plateau. Mr. R. S. Pepper gave a comprehensive account of the climate, products, and peoples of the Malabar coast, illustrated by excellent views. He pointed out the great progress which had been made during the past half century, and insisted on the economic value of the region. Major J. A. Burdon, Resident of the Sokoto Province, described the Fulani Emirates of northern Nigeria in a communication which it would be difficult to over-rate. The impressive contrasts between the conditions in this laterite plateau dissected by broad flat valleys, leaving monotonous table-topped hills covered with open brush, and the dense forests of southern Nigeria were admirably shown, and the resulting effects traced—Paganism and degenerate peoples in the forest belt, Islam and a well developed social organisation in the north. The effects of the nomad Fulani conquest of the region were traced, and form an interesting contribution of the evidence which goes to prove that a definite type of social organisation is connected with nomadic pastoral peoples all the world over, and that a fairly constant series of events follows the thorough conquest of a settled people by such nomadic tribes. The present British administration is fortunately inspired by the scientific spirit of constructive action based on existing institutions.

In 1903 Mr. Arthur Hill made a journey to Lake Titicaca. The uniformity of the vegetation at altitudes from 12,500 to 16,500 feet was striking; the plants growing in rosettes have long tap-roots by which they reach the warmer soil at some distance below the surface, and their leaves are linear and hairy, and suited to the dry air subjected to temperature variations of as much as 70° F. within a few hours.

Mr. D. G. Hogarth spent nearly a week in Cyrenaica in April, 1904, and was able to note certain geographical facts which explain some of the peculiarities of Cyrenaic history. He pointed out that changes of coastal level must have taken place since ancient times. This point is of considerable importance, as Mr. R. S. Günther showed by a series of maps and photographs of the Neapolitan region. In a paper descriptive of these he summarised the results of his investigations on the Bay of Naples,[1] where he found a mediæval land level 12 to 23 feet below the present one, and a Græco-Roman land level some 16 feet above the existing level, and therefore in places 40 feet above the mediæval one. Round Genoa the coasts were also lower in the thirteenth and fourteenth centuries, and the Nile delta has been shown to be higher in classical times. The old shore lines are not horizontal, and Mr. Günther considers that land oscillations have been the cause of the changes of level. In the discussion which followed Messrs. R. D. Oldham and J. Y. Buchanan both pointed out other changes which had been observed in the level of the Mediterranean. A special committee to investigate the evidence was appointed by the general committee. The two afternoon lectures arranged by this section had reference to the Mediterranean basin; and Dr. Tempest Anderson's views and description of the Lipari Islands reminded his hearers of the obvious unstable condition of part of it at the present day. Mr. Silva White's admirable account of the Nile Valley emphasised its organic unity, its physical and political insularity, which has resulted in the political control of Egypt since the time of Alexander the Great by the Power possessing command of the sea. He also showed some views, and gave an eloquent description of the desert barrier which surrounds it.

Coming to our own country, the papers dealt with problems within the sphere of influence of Cambridge. Mr. H. Yule Oldham, reader in geography at Cambridge, discussed the changes in the fen district since the seventeenth century, when the tides came up the Ouse and nearly reached Cambridge. By the cutting of the new Bedford River and the building of the sluice at Denver, the tidal waters were diverted up the new river, and this permitted the drainage of the fens. The old course of the Ouse was indicated in modern maps by the irregular boundary between Cambridgeshire and Norfolk, which followed it. Mr. R. H. Yapp dealt with the vegetation of the fen region, and by a series of excellent slides showed the characteristic forms found in different edaphic conditions. The Rev. Alfred Hunt claimed the hamlet of

[1] The full report is published in the *Geographical Journal* for August and September, 1903; and in *Archaeologia*, lviii.

Burnham, in the parish of Thornton Curtis, in north Lincolnshire, four miles from the Humber, where entrenchments have been found, as the site of the battle of Brunanburh, when, under Athelstane, the south of England obtained the dominance over the north.

Dr. Mill exhibited and described a map showing the names of the physical features of England and Wales to which the Royal Geographical Society's council had given its imprimatur. Mr. Whitaker protested against the use made of the term weald, the new name given to Ashdown Forest, and other points. It is to be hoped that after a thorough discussion by all interested a general agreement will be come to as to the use of topographical terms. The majority of those on the map will be accepted by all.

Three papers dealt with map-making. The Rev. H. S. Cronin described what he believed to be the way in which Ptolemy constructed his map of Asia Minor, and pointed out how wrong conclusions were certain to arise from treating it as if it were a modern map, or his geography as modern geography. Mr. C. R. Beazley contributed an account of the Portolani of the early fourteenth century, the first true maps of the Mediterranean. Major C. F. Close discussed the methods of topographical surveying suitable for different countries, choosing the United Kingdom, India, the Gold Coast, where "long traverses" are necessary owing to the dense forest making the cost of triangulation prohibitive, South Africa, already triangulated and ready for plane tabling, which can be carried out in the open country under very favourable conditions, and Canada, for which a scheme has recently been drawn up by Major Hills. In Canada, in very special circumstances, photographic surveying has been carried out, but Major Close considered that ordinary methods under ordinary conditions were better as regards accuracy, rapidity, and cost. This was queried in the subsequent discussion. Sir David Gill dealt with the condition of the South African survey, which owes so much to him.

FIG. 1.—A Roll Wave leaping the Outfall of the Grünnbach Conduit.

The report by Dr. Cornish of the committee on terrestrial surface waves and wave-like surfaces was read. It contained a description of roll waves, a term used to describe waves resembling a bore travelling down stream more rapidly than the current in such open paved conduits as the lower courses of the Guntenbach and Grünnbach, which flow into the Lake of Thun (see Fig. 1). The phenomenon has been noticed on the Tees. The committee was re-appointed.

The geographical section combined with the zoological one to recommend the appointment of a committee to carry on physical and biological investigations in the western Indian Ocean under the leadership of Mr. Stanley Gardiner. This was duly appointed, and a grant of 150*l.* assigned to it.

Another important committee was nominated on the joint recommendation of geologists and geographers to collect information and report on the meaning and distribution of local terms given to topographical and geological features.

CONFERENCE OF DELEGATES OF LOCAL SCIENTIFIC SOCIETIES.

TWENTY years have passed since the local scientific societies of this country first had the opportunity of coming into official relation with the British Association. Although it is believed that this relationship has been, in various ways, of much benefit to many of the societies, it must be admitted that the results, viewed as a whole, have hardly equalled the expectations which were originally entertained when the scheme of affiliation was projected. This view was prominently brought forward at the conference of delegates from the corresponding societies recently held at Cambridge.

The chairman of the conference, Principal E. H. Griffiths, F.R.S., of Cardiff, pointed out the desirability of binding together all the scientific societies of this kingdom, so that they could move, in matters of national importance, as one body. He pictured them, at present, as a scattered heap of iron filings, waiting for the British Association to act as a magnet in their midst, so as to "transform the confused assemblage into a field of symmetry and beauty."

The work of the local societies may be said, broadly speaking, to be of two kinds, *educational* and *technical*, the latter including observational and investigational work. Of these branches, the chairman was disposed, in the present state of things, to regard the former as the more important. "The work is educational not only in arousing intelligent interest in the facts of natural science and quickening in the individual the power of observation, but also in promoting the missionary spirit which will enable the members to excite the interest and sympathy of their neighbours."

In order to extend the influence of the British Association, Principal Griffiths suggested some relaxation in the rules which now regulate the admission of societies. At present no society can be brought into union unless it publishes the results of original investigations. But, said he, "it is very doubtful if publication *is* the best test of merit"; and he added that if we exclude those societies which "refrain from adding to the mass of literature under which there is danger of our being smothered, it is possible that we are excluding the very bodies whose sympathy and interest we should most wish to encourage."

Principal Griffiths was accordingly led to advocate the recognition of two classes of corresponding societies, one to be called affiliated societies, conforming to the existing regulations, the other to be called associated societies, including any local society which has existed for a period of, say, three years, and numbers not fewer than fifty members. "Surely," said the chairman, "we desire to throw our doors as wide open as possible, surely we wish to give every encouragement to all scientific societies, but more especially to those working under difficulties, to strengthen the hands of their promoters, and to ask their aid and assistance in our deliberations. Moreover, it is precisely those societies with narrow means, and whose members are possibly drawn from working classes, that can be of the greatest use to us. They are missionaries situated where we most want them, and preaching to the unconverted. This yearly meeting of single delegates from a few of the leading societies, although an admirable nucleus, is not sufficient to produce crystallisation of the scientific interests in solution in the population of this kingdom."

As a means of inter-communication between the societies, and with the view of uniting them "in common action for

the attainment of some purpose of national or scientific importance," Principal Griffiths advocated the publication of a *Journal of Corresponding Societies*, towards the expenses of which the various societies should contribute according to the respective numbers of their members.

The chairman's views were received with much favour by the delegates and others attending the meeting. Sir Norman Lockyer referred to his presidential address of last year, in which he suggested that the organisation of the corresponding societies might become a potent and valuable machine for influencing public opinion on matters relating to science throughout the country. He regarded the corresponding societies as having before them an important and undeveloped field of work. With regard to the Corresponding Societies Committee, he advocated more frequent meetings and a closer union with the central organisation of the British Association. Mr. W. Whitaker agreed with the chairman that the time was come when it seemed desirable to reconsider, and possibly revise, the old conditions regulating the affiliation of local societies. He considered that the maintenance of a good museum might be as much a ground for union as the publication of a volume of proceedings. The Rev. W. Stallworthy advised the appointment of a small number of competent members as inspectors, who should visit the various local societies and report upon their work to the authorities at headquarters. Prof. Ewing advocated the admission of the smaller societies in outlying districts, where publication was not to be regarded as the test of usefulness. Dr. G. Abbott supported the views of the chairman, and enlarged on the advantage of uniting societies in local groups. Many societies in the south-east of England had been strengthened by such a union. He thought that the British Association should get into touch with as many societies as possible, and that no barrier should be raised, such as that of publication. The Rev. T. R. R. Stebbing deprecated publication being used as a test of the usefulness of a society. If the paper were important, it ought to go to a central society, and not be published locally; if it were unimportant, it were better not published at all.

Ultimately a committee was appointed to consider the present relation between the British Association and the local scientific societies, and to make suggestions to the council with a view to the greater utilisation of this relationship, and the extension of affiliation to societies now excluded.

The subject of museums, which has often been discussed at the annual conference of delegates, was brought forward by the Rev. W. Johnson, of York, who read a paper on the utilisation of local museums, with special reference to schools. He believed that provincial museums have often failed in developing the scientific habit in visitors, because they have given too much prominence to rarities, whereas the beginner needs illustrations of common objects, such as he is likely to find in his own study in the field. A large amount of material now lies buried in our museums needing judicious display and description to render it available to the young student. Mr. Johnson held that every museum should have attached to it a demonstration room, fitted with lanterns and other lecture-room appliances, and he considered that demonstrations by competent persons might well be paid for by the State, in consideration of their value in assisting the higher science teaching in our schools. The excellent work of Mr. Crowther, the curator at Leeds, in giving demonstrations to children from the local schools, was referred to with warm approval. Mr. Johnson recommended that during the winter-holidays museum-lectures should be given on elementary meteorology, explaining the nature and use of the various instruments which are used at most museums for obtaining weather records.

In discussing the paper, Mr. Rudler referred to the difficulties incidental to museum demonstrations, and advocated the delivery of the lecturette in a separate room, followed by adjournment to the museum. The interest of the delegates in the museum question centred in the point of contact between the local museum and the local society, and he referred to some of the ways in which the society might assist the museum, such as the frequent display of fresh specimens of wild flowers with instructive labels. Whilst admitting the importance of taking children to the museum, he held that it was equally desirable to take the museum to the children, and he consequently favoured the practice of circulating educational cabinets of specimens among the local schools.

At the second meeting of the delegates, Mr. J. Hopkinson, of the Hertfordshire Natural History Society, brought forward a very practical subject relating to the publications of scientific bodies. He denounced the insufficiency of the title given in certain papers, and the absence of an index, a table of contents, or a list of plates in the publications of many societies. The date of publication of each part or number of a volume of proceedings should always be given, and in the case of reprints of papers, the original pagination should be preserved, whilst the date and volume of the publication from which they are extracted should invariably be stated. Dr. Tempest Anderson, who presided at the second meeting of the delegates, spoke strongly in favour of securing uniformity in the size of the publications of scientific societies.

In the discussion on the aid which local societies could give to the work of the committees of various sections of the British Association, Dr. H. R. Mill, as a delegate from Section A, pleaded for increased interest in meteorology, and urged the local societies to take regular and systematic observations. Mr. Whitaker, on behalf of Section C, solicited the aid of the societies in seeking the derivation and precise significance of local terms relating to geological and geographical subjects—an appeal which was supported by Dr. Herbertson, representing Section E. The Rev. T. R. R. Stebbing, speaking for Section D, suggested, as additional work for local societies, the study of overland lines of migration of birds, and the collection of slugs from all parts of the British Isles. Miss Sargent solicited information with regard to certain points in the growth of British orchids. The conference was not favoured with suggestions from any of the other sections.

EOCENE WHALES.

A MOST important contribution to our knowledge of the extent and affinities of that group of Eocene marine mammals known as Archæoceti has recently been made by Prof. E. Fraas, of Stuttgart, in an illustrated memoir entitled "Neue Zeuglodonten aus dem unteren Mitteleocän vom Mokattam bei Cairo," published in Koken's *Geologische und Palaeontologische Abhandlungen.* The Archæoceti, or zeuglodonts, which have hitherto been definitely known only by various species of the typical genus Zeuglodon, have been regarded by many zoologists as the direct ancestors of the modern whales and dolphins, and if this view be accepted, it has for some time been evident (although this was not the opinion of the late Sir William Flower) that the toothed whales, at any rate, are probably the descendants of carnivorous mammals, as it seemed impossible that the zeuglodonts could be derived from a herbivorous type.

The carnivorous descent of the zeuglodonts is now fully demonstrated by Prof. Fraas, who describes two new generic representatives of the group—Protocetus and Mesocetus—from the well known Middle Eocene nummulitic rocks of the Mokattam range near Cairo. Of the former genus the author figures a nearly complete skull, together with many of the bones of the skeleton. In both genera the teeth are of the typical mammalian number, and divisible into incisors, canines, premolars, and molars, the latter, in Protocetus at any rate, being quite unlike the corresponding teeth of Zeuglodon, and approximating to those of the primitive Eocene Carnivora of the group Creodontia. The skull, moreover, although much more elongated than in any of the land forms, presents all the distinctive characteristics of the latter group, and there can be little hesitation in accepting Prof. Fraas's view that Protocetus and Mesocetus form connecting links between the terrestrial creodont carnivores on the one hand and the marine zeuglodonts on the other. They are, in fact, terrestrial animals in course of modification into purely aquatic ones. Prof. Fraas does not, however, by any means stop at this, but proceeds to argue that the Archæoceti are entirely unconnected with either the whalebone or the toothed whales, and merely form a marine group of Creodontia which died out without leaving any descendants. As he rightly observes,

we have evidence that members of several distinct groups of reptiles—the ichthyosaurs, the plesiosaurs, the marine crocodiles, and the mosasaurs—were independently modified for a marine existence, and there is no reason why a similar state of affairs should not have occurred among mammals.

This is doubtless true; but it has to be borne in mind that, so far as we can see, the new discoveries in no wise affect the alleged relationship of Zeuglodon to the Cetacea, which, if well founded previously, apparently still remains so. Moreover, if we remember rightly, Dr. Elliot Smith, in a recent paper on the brain of the Archæoceti, has pointed out very definite cetacean resemblances, which it would be difficult to explain as due solely to parallelism. Again, if we remove the Archæoceti from the cetacean line, there are no possible ancestors for the whales to which we can point, and, in the present comparatively advanced position of the palæontological record, it would be strange indeed if the past history of the Cetacea (with the exception of forms belonging to the existing groups) were an absolute and complete blank.

While according therefore to Prof. Fraas full credit for having brought the zeuglodonts into phylogenetic relationship with the creodont carnivores, we may be permitted, perhaps, to reserve our judgment as to whether he has succeeded in demonstrating the absence of relationship between the former group and modern whales.

R. L.

FORTHCOMING BOOKS OF SCIENCE.

MR. GEORGE ALLEN directs attention to:—"The Glamour of the Earth," by G. A. B. Dewar, illustrated; "A Volume on Bird Life," by E. Selous, illustrated; and "Recent Discoveries and Excavations in the Forum, 1898 to 1904," by St. Clair Baddeley, illustrated.

Mr. Edward Arnold announces:—"The Becquerel Rays and the Properties of Radio-active Substances," by the Hon. R. J. Strutt; "The Chemical Synthesis of Vital Products and the Inter-relations between Organic Compounds," by Prof. R. Meldola, F.R.S.; "Experimental Researches with the Electric Furnace," by Prof. H. Moissan, translated by Dr. A. T. de Mouilpied; "Physical Chemistry in Biology and Medicine," by Prof. B. Moore; "Astronomical Discovery," by Prof. H. H. Turner, F.R.S.; "The Theory of Optics," by Prof. A. Schuster, F.R.S.; "Preliminary Practical Mathematics," by S. G. Starling and F. C. Clarke; "The Evolution Theory," by Prof. A. Weismann, translated by Prof. J. A. Thomson, two volumes, illustrated; "Nature Study in the House, Garden, and Field," by Prof. L. C. Miall, F.R.S.; "Lectures on Diseases of Children," by Dr. R. Hutchison; "A Manual of Pharmacology for Students," by Dr. W. E. Dixon; "Recent Advances in Chemical Physiology," by Drs. A. P. Beddard, L. Hill, F.R.S., J. J. R. Macleod, B. Moore, and M. S. Pembrey; "Exercises in Arithmetic," oral and written, by C. M. Taylor, part iii.; "The Elements of Trigonometry," by Dr. R. Lachlan and W. C. Fletcher; "A Second Geometry Book," by J. G. Hamilton and F. Kettle; and new editions of "Electrical Traction," by Prof. E. Wilson; and "Human Embryology and Morphology," by Dr. A. Keith, illustrated.

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In Mr. Murray's list are to be found:—"Recent Development in Biological Science," by W. B. Hardy, F.R.S.; "Bacteriology and the Public Health," by Dr. G. Newman; "The Culture of Fruit Trees in Pots," by J. Brace, illustrated; "River, Road, and Rail, some Engineering Reminiscences of Undertakings in Various Parts of the World, including the St. Gothard Tunnel and the Zambesi Falls Bridge," by F. Fox, illustrated; "Hints on the Horse, for Artist and Buyer," by Captain C. N. Gonne, R.A., illustrated; "The Moon, a Summary of the Existing Knowledge of our Satellite, with a Complete Photographic Atlas," by Prof. W. H. Pickering, illustrated; "Artillery and Explosives, Essays and Lectures Written and Delivered at Various Times," by Sir A. Noble, K.C.B., F.R.S., illustrated; in the "Progressive Science" Series:—"Earthquakes, in the Light of the New Seismology," by Major C. E. Dutton, illustrated; and "Heredity," by Prof. J. A. Thomson, illustrated; also "Growth and Spread of Culture," by Prof. E. B. Tylor, F.R.S., illustrated; "A Second Course of Practical Science," by J. H. Leonard and W. H. Salmon; "A Primer of Botany," by Prof. J. B. Farmer, F.R.S.; "The Vegetable Garden, or the Edible Vegetables, Salads, and Herbs Cultivated in Europe and America," by W. Robinson; and a new edition of "Marine Boilers, their Construction and Working, Dealing more Especially with Tubulous Boilers," based on the first edition of the work by M. L. E. Bertin, brought up to date, edited by L. S. Robertson.

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Mr. D. Nutt announces:—"Folk-lore of the Musquakie Indians of North America and Catalogue of Musquakie Beadwork, and other Objects in the Collection of the Folklore Society," by M. A. Owen, illustrated.

Messrs. G. P. Putnam's Sons' announcements include:—"The Heart of the Orient: Saunterings through Georgia, Armenia, Persia, Turkomania, and Turkestan, to the Vale of Paradise," by M. M. Shoemaker, illustrated; "Strabismus, or Squint, Latent and Fixed, a Supplement to 'Errors of Refraction,'" by Dr. F. Valk; "Field Book of Wild Birds and their Music, being a Description of the Songs and Colouring of Wild Birds intended to Assist in the Identification of Species Common in the Eastern United States," by F. S. Mathews, illustrated; "An Introduction to Vertebrate Embryology Based on the Study of the Frog and the Chick," by Dr. A. M. Reese; "Bog Trotting for Orchids," by G. G. Niles, illustrated; "The Mystic Mid-Region, the Deserts of the South-west," by A. J. Burdick, illustrated; "The Trees of North-eastern America," with introduction by N. L. Britton; and new editions of "Landscape Gardening," by S. Parsons, jun.; and "The Shrubs of North-eastern America," by C. S. Newhall, two vols. in one, illustrated.

The Walter Scott Publishing Co., Ltd., give notice of:—"A Study of Recent Earthquakes," by Dr. C. Davison; "Science and Hypothesis," by Prof. H. Poincaré, translated by W. J. Greenstreet; and a new edition of "Electricity in Modern Life," by G. W. de Tunzelmann, illustrated.

The announcements of Messrs. Swan Sonnenschein and Co., Ltd., include:—"Physiological Psychology," by Prof. W. Wundt, a translation of the fifth and wholly rewritten (1902–3) German edition by Prof. E. B. Tichener, in three vols., vol. i., illustrated; an abridged edition of Erdmann's "History of Philosophy," based on the fifth German edition, revised by Dr. B. Erdmann, translated and edited by W. S. Hough; "A Philosophical Introduction to Ethics," by W. B. B. Gibson; "Thoughts and Things: a Genetic Study of Logical Process," by Prof. M. Baldwin; "Student's Text-book of Zoology," by A. Sedgwick, F.R.S., vol. ii., illustrated; and new editions of "Handbook of Systematic Botany," by Dr. E. Warming, translated and edited by Prof. M. C. Potter, illustrated; "Introduction to the Study of Organic Chemistry," by J. Wade, illustrated; and "Sanatoria for Consumptives in Various Parts of the World," by Dr. F. R. Walters, illustrated.

Mr. E. Stanford announces:—"The Sea Fishing Industry of England and Wales, a Popular Account of the Sea Fisheries and Fishing Ports of those Countries," by F. G. Aflalo, illustrated; "Stanford's Compendium of Geography and Travel" (supplementary volume), "Glossary of Geographical and Topographical Terms, and of Words of Frequent Occurrence in the Composition of such Terms and of Place Names," by A. Knox; "Stanford's Geological Atlas of Great Britain (based on Reynold's Geological Atlas), with Plates of Characteristic Fossils, Preceded by a Description of the Geological Structure of Great Britain and its Counties, and of the Features Observable along the Principal Lines of Railway," by H. B. Woodward, F.R.S., illustrated; and a new edition of "Stanford's Compendium of Geography and Travel"—"Africa, vol. ii., South Africa," by Dr. A. H. Keane, illustrated.

Messrs. W. Thacker and Co. promise:—"The Exploration of Tibet," by G. Sandberg; "The Birds of Calcutta," by F. Finn; "Indian Electricity Act, 1903," by J. W. Meares; and new editions of "Game, Shore, and Water Birds of India," by Colonel Lemessurier; and "Astronomy without a Telescope," by E. W. Maunder.

The University of Chicago Press (Chicago) will publish:—"Studies in General Physiology," by Dr. J. Loeb, two vols.; and "Lectures on the Calculus of Variations," by Prof. O. Bolza.

Mr. Fisher Unwin announces:—"Travel, Exploration and Climbing in Siberia," by S. Turner, illustrated; "The Land of the Horn," by W. S. Barclay, illustrated;

"Through Town and Jungle: Fourteen Thousand Miles Awheel among the Temples and People of the Indian Plain," by W. H. and F. B. Workman, illustrated; "British Bird Life," by W. P. Westell, illustrated; and "Gardening for the Million," by A. Pink.

Messrs. Whittaker and Co.'s announcements are as follow:—"Insulation of Dynamo Electric Machinery," by H. W. Turner and H. M. Hobart; "Armature Construction," by H. M. Hobart; "Steam Turbines," by H. M. Hobart and T. Stevens; "Concrete-Steel," by W. Noble Twelvetrees; "Practical Wireless Telegraphy," by Prof. Mazzotto, translated from the Italian by S. Bottone; "Percentage Tables for Elementary Analysis," by L. F. Guttmann; and new editions of "The Alternating Current Circuit and Motor," by W. P. Maycock; "Electricity in its Application to Telegraphy," by T. E. Herbert; "Central Station Electricity Supply," by A. Gay and C. H. Yeaman; "The Management of Accumulators," by Sir D. Salomons; and "The Optics of Photography and Photographic Lenses," by J. T. Taylor, revised by P. F. Everitt.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Mr. George H. Carpenter, of the Science and Art Museum, Dublin, has been appointed professor of zoology in the Royal College of Science for Ireland.

At the inaugural ceremony in connection with the University of Leeds on Thursday, October 6, the following honorary degrees, among others, will be conferred:—D.Sc., Lord Rosse, Lord Kelvin, Sir Isaac Lowthian Bell, Sir James Kitson, M.P., Sir William Henry Broadbent, Sir Arthur W. Rücker, Dr. Thorpe, C.B., Dr. C. G. Wheelhouse, Mr. Jonathan Hutchinson, Mr. J. P. Teal, Dr. H. Jackson, Prof. Miall, Dr. Tempest Anderson, and Prof. A. W. Mayo Robson.

The inaugural lecture of the new session of the London School of Economics and Political Science will be given by the director, Mr. H. J. Mackinder, on Monday, October 3, on "The Need of Scientific Method in Affairs." The arrangements for the session include courses of lectures on all branches of economics, sociology, and cognate subjects of decided value in the development of a scientific spirit in commerce and industry. Among the lecturers are Mr. A. L. Bowley, Dr. E. Cannan, Mr. H. S. Foxwell, Prof. A. C. Haddon, Mr. A. W. Pollard, and Dr. E. A. Westermarck.

The Department of Agriculture and Technical Instruction for Ireland proposes to establish for the year 1904–5 a limited number of commercial scholarships, tenable for one year only (value 100*l*. each), at such schools as the department may approve; also one scholarship for persons engaged in the woollen industry, and one for those engaged in the leather and tanning industries. These scholarships will be tenable at some higher institution, to be approved by the department, in which these industries are taught. They will be of the value of 80*l*. each, and may be renewable for second and third years at the discretion of the department. Candidates for the scholarships must apply for forms, which should be returned to the department duly filled in not later than October 5.

It is announced in the *British Medical Journal* that Lord Strathcona and Mount Royal, the Chancellor of McGill University, Montreal, has presented the sum of 10,000*l*. to the medical faculty. This is in addition to a gift of 20,000*l*. which Lord Strathcona made to the medical faculty about two and a half years ago. The whole of that sum was expended in alterations and extensions of the buildings of the faculty; these were so extensive that they practically amounted to rebuilding. Two new lecture rooms, and three laboratories for chemistry, physics, and hygiene respectively were erected, and other alterations and additions made which greatly increased the working power of the faculty. These buildings, which were opened by the Prince of Wales about two years ago, cost some 750*l*. more than was expected. The further sum now given by Lord Strathcona is intended to cover the deficit and to assist the general work of the medical school.

At University College, London, on October 3, Prof. Norman Collie will give a public introductory lecture to the faculty of medicine on "The Bearing of Chemistry on Medicine." On October 18 Sir William Ramsay will commence a course on the chemical aspects of the recent discoveries connected with radio-active matter. A course of lectures on spectroscopy and spectrum photography, by Mr. E. C. C. Baly, will be given twice during the session, beginning in November and February.

A list of courses of lectures and practical work at Herold's Institute—the London Technical School of Leather Manufacture—has been received. The school is a monotechnic equipped with every appliance requisite for the practical manufacture, currying, dyeing, and finishing of all kinds of leather. Students are urged to go through courses of study of two or three years' duration, and every possible facility is afforded to those who desire to carry out original researches.

The syllabus of classes at the Sir John Cass Technical Institute, Aldgate, shows that much care has been devoted to the organisation of the work of the institute, which is now an educational centre for industrial classes, men and women, of east London. The institute has now completed its first two sessions, and a fairly definite line has been taken in the science teaching, which is chiefly concerned with physics, chemistry, and metallurgy, whilst these departments are correlated to the department of arts and crafts in respect to the teaching of art metal work, jewelry, and enamelling. Metallurgy is one of the more special departments of the institute, and we notice that a course is announced on metallography.

At St. Thomas's Hospital Medical School the entrance scholarship in natural science, of the value of 150*l*., has been awarded to Mr. Ernest W. Withey, and the university scholarship, of the value of 50*l*., to Mr. Charles E. Whitehead, of Caius College, Cambridge.

SOCIETIES AND ACADEMIES.

London.

Royal Society, July 26.—"On the Production of a Specific Gastrotoxic Serum.—Preliminary Communication." By Dr. Charles **Bolton.** Communicated by Prof. Sidney Martin, F.R.S.

This communication deals with the production of a gastrotoxic serum by the injection of the mucous membrane of the stomach (1) of the guinea-pig into the rabbit, (2) of the rabbit into the rabbit, and (3) of the guinea-pig into the guinea-pig.

In each case the blood of the injected animal becomes toxic; in the first case for the guinea-pig, in the second case for the guinea-pig, and in the third case for the rabbit.

The lesions produced by injection of the serum are in all three cases the same. They consist of circumscribed areas of necrosis in the mucous membrane of the stomach associated with hæmorrhage, the latter being secondary to the necrosis, and to some extent also of hæmolytic origin. At a later stage definite ulcers of the stomach are produced, and in this process of ulceration the gastric juice is considered to play a prominent part. The remaining portions of the alimentary canal are found to be normal. The gastrotoxic serum does not produce any visible change in the stomach cells which are exposed to its action *in vitro*.

An inquiry into the nature of the gastrotoxin has shown that it consists of an "immune body," which is newly formed in the blood and resists the action of heat, and a "complement" which is contained in the normal blood and is destroyed by heat.

The specificity of the gastrotoxin was tested by mixing various cells (such as liver, blood) with it previous to its injection in order to determine whether guinea-pig's stomach cells alone, or whether any other cells, could extract the "immune body." As the result of this, it was found that guinea-pig's stomach cells alone in the first two cases were able completely to extract the "immune body" and thus

render the serum inactive. It was, however, found, on immunisation of a rabbit against guinea-pig's stomach cells washed quite free from blood, that the hæmolytic power of the rabbit's serum for guinea-pig's red blood corpuscles was much increased, and therefore that the gastric cells possess receptors to some extent in common with red blood corpuscles. The gastrotoxin is thus shown to consist of two factors:—(1) gastrotoxic, (2) hæmolytic.

The hæmolytic factor is by no means the more important, because the lesions produced were in the hitherto observed cases limited to the stomach, the hæmolytic factor could be extracted from the serum leaving the gastrotoxic factor, and in many cases no evidence of hæmolysis could be found on microscopic examination of the lesions.

In the case of the gastrotoxic serum produced by injection of the stomach cells of the rabbit into the rabbit, it was found that although the rabbit's stomach cells possessed an affinity for the gastrotoxin, yet they completely failed to extract the "immune body" when exposed to the action of the serum *in vitro*. It is therefore concluded that probably this phenomenon, together with absence of autolysis, may be explained by the presence of an "anti-immune body" which is concomitantly formed by the rabbit to protect itself from the effects of the poison which it is manufacturing.

This opens up a hitherto unexplored field in the pathology of human gastric ulcer.

Paris.

Academy of Sciences, September 19.—M. Mascart in the chair.—On the production of sugar in the kidney of a dog to which phloridzin has been administered: R. **Lépine** and M. **Boulud.** It is shown that the sugar obtained in experiments in glass does not give an exact measure of the sugar actually present in the blood in the veins.—On the depth of field and focal length of photographic objectives: J. **Thovert.** Regarding the object of photography as the reproduction of an object as seen by the eye, the limit of angular definition of a photographic image should be about 1/3000. It is shown that this ideal cannot be attained for lenses of short focal length.—On the chemical composition and formula of adrenalin: Gabriel **Bertrand.** Three formulæ have been proposed for adrenalin, the active substance in the extract of suprarenal capsules. Starting with 118 kilograms of the fresh organs, from 4000 horses, 125 grams of crystallised adrenalin were obtained, and this was submitted to an elaborate fractional precipitation. The figures obtained by combustion analyses of the various fractions were very concordant, and show that crystallised adrenalin extracted from the suprarenal capsules of the horse is a distinct substance and not a mixture. The molecular weight was fixed by the lowering of the freezing point of glacial acetic acid, and the formula of the substance fixed as $C_9H_{13}NO_3$, this agreeing with the views of Aldrich.—The nomenclature of the rosanilines: Jules **Schmidlin.**—Tetraoxycyclohexane-rosanilines: a new class of colourless derivatives: Jules **Schmidlin.** The formation of this new class of compounds depends on a simple hydrolysis which rosaniline salts undergo in acid solution. The conclusion is drawn from these experiments that the salts of rosanilines contain four double linkages of the fatty type.—Ultramicroscopic observations on solutions of pure glycogen: Wilhelm **Biltz** and Madame Z. **Gatin-Gruzewska.** Two sets of experiments are described. The first set, agreeing with the results of Raehlmann, show that an aqueous solution of glycogen contains particles of different diameters, varying with the condition of the solutions. In the second set, the effect on the size of the particles by precipitation with gradually increasing quantities of precipitants was studied.

New South Wales.

Royal Society, August 3.—Mr. C. O. Burge, president, in the chair.—On Eucalyptus kinos, their value for tinctures, and the non-gelatinisation of the product of certain species: H. G. **Smith.** In this paper, which is the second of the series dealing with Eucalyptus kinos, the author shows that the tannins in the exudations from the various Eucalypts vary largely in character, and that while some kinos gelatinise in tinctures, others do not. There is a remarkable regularity in the action of kinos from allied species, and the marked differences in the tannins themselves appear to be the reason why they act so differently as regards gelatinisation. There are three tannins at least in Eucalyptus kinos, and all are determinable by reagents.—On some hydrographical data in relation to ocean currents: H. A. **Lenehan.** A paper dealing with ocean drifts, principally in the southern hemisphere. It contains a tabulated statement of 182 records, the most important of which travelled a distance of 11,350 miles between June 19, 1901, and March 5, 1904, at a daily rate of 11½ miles. There are also eleven other drifts more than 3000 miles long. Two charts accompany the paper, showing the positions where the records were cast adrift and the places where found.

Göttingen.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iv. for 1904, contains the following memoirs communicated to the society:—

July 9.—W. **Nernst**: On the formation of nitrogen dioxide at high temperatures. H. **Gerdien**: Measurements of atmospheric electricity during two balloon ascents. Wilhelm **Biltz**: Ultra-microscopic observations, i. The precipitation of sulphur from thiosulphuric acid and of selenium from selenious acid.

June 25.—H. **Minkowski**: On the closest possible parallelopipedal piling of congruent solids.

July 23.—Eduard **Riecke**: Researches on the phenomena of discharge in Geissler tubes, i. On the exhaustion of Geissler tubes by the electric current.

CONTENTS.

THURSDAY, OCTOBER 6, 1904.

THE NORTH POLAR SEAS.

The Norwegian North Polar Expedition, 1893–1896. *Scientific Results.* Edited by Fridtjof Nansen. Vol. iv. Published by the Fridtjof Nansen Fund for the Advancement of Science. Pp. 232; 32 plates. (London: Longmans, Green and Co., 1904.) Price 21*s.* net.

THE present volume, in continuation of those previously published,[1] contains three articles, which may be noticed in sequence, although the contribution by Dr. Nansen constitutes the principal portion of the work.

In article xi. H. H. Gran deals with "Diatomaceæ from the Ice-floes and Plankton of the Arctic Ocean." It is pointed out that the plankton samples collected on previous expeditions to the Polar seas contained a considerable quantity of algæ, especially diatoms; whereas the samples brought home by Nansen indicate that the deep Polar Sea is deficient both in species and specimens. When found in quantity, they were principally oceanic diatoms; but the author remarks that it is difficult to understand how all the crustaceans (*Calanus finmarchichus*, &c.) that swarm in the upper portions of the Polar Sea can find means of sustaining life. The samples of diatoms taken upon the drift-ice, partly upon the ice-floes and at their edge, partly from channels in the ice, are of greater botanical interest. Most of them must have lived and multiplied on the ice; others, including a few fresh-water forms, were probably transported casually on to the ice. At present little is known concerning the distribution of ice-diatoms, but the samples examined indicate that those of North Siberia and East Greenland are directly connected with one another; and the study of these organisms appears likely to prove of value in determining the drift of the ice.

In article xii. Johan Kiær describes "The Lower Silurian at Khabarova." Fossiliferous calcareous slates were discovered by Nansen in 1893 on the south side of Yugor Strait, near Khabarova, south-west of the Yalmal peninsula. The fossils, though badly preserved, could be identified as belonging to the brachiopods *Leptaena sericea*, Orthis and Strophomena; and to the trilobites Asaphus, Megalaspis, and Remopleurides. They indicate the zone of *Asaphus platyurus*, which belongs to the middle part of the Ordovician.

In article xiii. Nansen contributes an elaborate essay on "The Bathymetrical Features of the North Polar Seas, with a Discussion of the Continental Shelves and Previous Oscillations of the Shore-line." This work, illustrated by 29 maps and profiles, embodies the more important observations and conclusions of the great explorer; and it will be of considerable interest to geologists, as well as to geographers, as some aspects of the subject have been vigorously discussed by Prof. Hull, Dr. J. W. Spencer, Mr. Hudleston, and Sir Archibald Geikie.

[1] Notices of previous volumes appeared in NATURE for June 14, 1900, p. 146; June 13, 1901, p. 151; and December 4, 1902, p. 97.

As pointed out by the author, the general idea prevailing before the expedition was that the North Polar ocean, between Siberia and North America, was a shallow sea, with a comparatively rapid deposition of sediments carried into it by the Siberian and American rivers, or brought from the coasts by drifting ice. The expedition has shown that the sea occupies a basin with depths approaching 4000 metres, and that at present there is no rapid deposition in it of sediments. Even the dust carried by the winds, or otherwise derived from the atmosphere by precipitation, settles on the floating ice, giving it a dirty brown appearance, and is transported to more southern latitudes, where the ice melts. Proof has likewise been obtained that Franz Josef Land is a group of comparatively small islands, and that probably no extensive land-masses exist to the north of the New Siberian Islands. The deep basin appears to be separated from the Norwegian sea by a shallow suboceanic ridge extending from Spitsbergen to Greenland.

As the *Fram* was heavily laden, Nansen had not encumbered her with the equipment necessary for sounding in very deep water. In the course of his drift across the North Polar basin he soon discovered that his arrangements for sounding were insufficient, and new line had to be made from one of the ship's thick steel-wire cables. Eventually, after much arduous labour, a fairly good sounding line, 4450 metres long, was constructed. According to the soundings thus made, and to those known from other expeditions, a chart has been prepared to show the bathymetrical conditions of the northern seas, but much naturally remains to be done to delineate in detail their submarine contours. The most striking feature in this region is the broad and shallow continental shelf extending northwards from the Eurasian continent, and on which are situated Bear Island, Spitsbergen, Franz Josef Archipelago, and Novaya Zemlya. Continued as it is along the American borders, it forms the most extensive submarine shelf. Davis Strait, with the deep Baffin Bay, and the Norwegian sea with the deep depression of the North Polar basin, form, with their many branches (*e.g.* the Barents Sea), enormous fjords penetrating this platform. Soundings show that its depths are, on the whole, very uniform.

The Siberian continental shelf is regarded as a submerged tract that was originally sculptured with furrows which were the continuations of the sounds, fjords, and valleys of the borderland. These depressions may have been filled up by ground moraines during the Glacial epoch, and also by the deposition of glacial sediments outside the margin of the Siberian ice-sheet, as well as by comparatively recent silting up by deposits from the rivers and shores. Floating ice also assisted in the process.

After describing the American Arctic continental shelf, the author discusses the features of the Barents, Murman, and Kara seas, in which he infers evidence of sculpturing by subaërial agents, fluviatile and glacial. It is interesting to read (p. 28) that "the possibility exists that there has

been no oscillation of sea level, but that the channels may have been excavated by glaciers to their present position below the sea surface"; and, although the author does not regard this possibility as of much weight, we may recall attention to the interesting suggestion (quoted in NATURE, July 7, p. 218) made by Mr. G. K. Gilbert, from his observations on Alaska, that glaciers, under certain conditions, may excavate beneath sea-level.

The continental shelf of the Norwegian coast is somewhat irregular, the depth of the edge below sea-level differing much between 80m. and 300m., and it is only at a few places that it is as deep as 360m. (200 fms.). The great valleys and fjords of the land are often continued as submarine valleys or fjords across the submerged continental shelf, and at some points they open out at its edge, forming distinct incisions in the continental slope; but they are not as a rule traceable beyond the 400 metres line, and seldom even so far.

The Norwegian submarine channel at the southern end of Norway is regarded as part of the bed of the ancient "Baltic River," which drained the Baltic basin and southern Scandinavian tracts. It is pointed out that Prof. Amund Helland attributed this channel to the erosion of the Scandinavian glacier during the Great Ice Age, and the author, while admitting the influence of that glacier, considers that the present relative depth is due to the adjacent areas having been to a great extent filled up with glacial drift.

After dealing briefly with the regions of the Færoës and Iceland, and with the continental shelves of Britain, France, and North America, the author summarises his views on the general subject of the origin of continental shelves. He discusses also various explanations that have been given.

Regarding the continental shelves as having been shaped prior to the submerged valleys, and considering the great extent of these shelves, and the improbability of regular and extended vertical movements of the lithosphere, the author in 1901 had concluded that they must be due to oscillations of the hydrosphere. He now considers that the general level of the sea must have remained near its present position, despite many oscillations of the land, during the later geological periods. The eroded parts of the continental shelves must have been developed when the shelves were near to sea-level, owing their features partly to conjoint action of subaërial erosion and marine denudation, partly to deposition of terrigenous waste, and even locally to organic agents.

Attention is directed to the extensive coast platforms that occur in part a little below sea-level and extend above it, evidencing small oscillations of the shore-line. The Norwegian coast platform has a surface formed chiefly by solid rocks, and the depressions in it are not filled up to any great extent by waste or glacial drift. This platform was in the author's opinion formed by marine denudation after the fjords and channels now traversing it were cut; but the sculpturing may have been facilitated by the clearing away of débris by glacial action. He believes that marine denudation is most potent when coasts are being slowly submerged; but that the Norwegian platform can hardly have been formed during one period of submergence. These platforms were formed in comparatively recent times, whereas the continental shelves were to a great extent developed during Pliocene and Pleistocene times.

With regard to the oscillations of the land, the author leaves the explanation in a somewhat vague state, observing in conclusion that

"whatever the causes of the oscillations of the shore-line may have been, the above facts seem to prove that, after each disturbance in the relation between land and sea, the earth's crust has a remarkably strong tendency to return to a certain position of perfect equilibrium, which is probably determined by the buoyancy of the crust floating on the underlying magma."

H. B. W.

FOREST ENGINEERING.

A Manual of Forest Engineering for India. By C. G. Rogers. Vol. i., pp. xx+321, price 6*s*. Vol. ii., pp. xix+267, price 6*s*. Vol. iii., pp. xii+392, price 7*s*. 6*d*. (Calcutta: Office of the Superintendent of Government Printing, India.)

THE manual under notice was written by order of the Indian Government. The work covers the syllabus of the course of study at the Imperial Forest School of Dehra Dun, but, in addition to this, there is much useful information included, giving the book a wider scope than the necessarily limited one of a syllabus of systematic instruction. The manual has been divided into eight parts. The separate parts deal with the following subjects:—(1) building materials; (2) building construction; (3) road making; (4) bridges; (5) transport of timber; (6) wells; (7) construction of embankments and water channels, river training works; (8) demarcation of forests.

In part i. we have a vast amount of information of the most useful kind on such materials as stone, bricks, tiles, lime, and timber. The source, strength, durability, preparation, and preservation of those various materials have been fully dealt with, each under its own heading. The last section of this part is devoted to carpentry and joinery, which, although not coming strictly under the heading of building materials, fit very well into this place as the most convenient for reference. Part ii., which is devoted to building construction, includes much eminently sound and useful information concerning foundations, walls, arches, floors, stairs, roofs, &c. All the best authorities have been consulted, and no suggestion or recommendation has been made which cannot be easily and successfully put into practice by the forester with such materials as he may find ready to hand and most suitable for his purpose, situated as he often is in out-of-the-way parts of the world, where not only the advice of a specially trained engineer, but also manufactured building materials are unobtainable. These two parts complete the first volume of the manual.

Parts iii. and iv., which deal respectively with road making and bridges, form vol. ii.; here again the parts have been subdivided into sections. The various problems and practical operations are dealt with in a very explicit and satisfactory manner. In this volume, as well as in the others, many useful figures and illustrations are given which supplement and enhance the value of the text. Parts v. to viii. are included in the third and last volume of the manual. As the author points out, this volume deals with those subjects which are of special interest to the forest manager. In dealing with the transport of timber, the author has given a complete account of the different methods of transport by roads, slides, forest tramways, wire-rope ways, and water. Each method has its own particular advantage, according to circumstances, which vary from place to place, but, with this volume as a guide, the forester need have no difficulty in selecting the method best suited to his own local conditions.

As the title indicates, the manual is intended for the use of forest officers in India, to whom it cannot fail to be of the greatest service and value. Great care has been taken to make the work as accurate and up to date as possible, and with this end in view the author sent proofs of the different parts of the manual to the Inspector-General of Forests to the Government of India and all conservators of forests for circulation among such forest officers as they might select for the purpose of recording any suggestions which they had to make; hence before publication the book was subjected to a thorough, practical, and critical examination, which renders it a standard authority and trustworthy source of reference.

While not replacing any of the standard works on civil engineering, the manual fills a big gap in the literature, and it is written in such a way that even those who have not had a special training in engineering may understand and appreciate its use. This work merits, and will no doubt attain, a wide circulation outside India. As a work of reference it should be in the hands of all whose profession brings them in contact with such engineering operations as do not require the skill of a highly trained expert.

There is a marked absence of technical terms, and where the use of these is unavoidable the author takes good care to make their meaning thoroughly clear. The illustrations form a very valuable feature of the manual, and greatly increase its practical utility. In most cases a detailed description has been appended, so that each figure may be clearly understood without any further reference to the text. The majority of these illustrations were drawn specially for the manual, a fact which adds much to their value. For the few illustrations which have been borrowed from other sources ample acknowledgment is made.

It will thus be seen that the manual embraces a wide range of subjects, all of which are pretty intimately associated with forestry. The third volume is of special interest to the forest manager, while vols. i. and ii. cannot fail to be also of great utility and value to those concerned in agriculture, horticulture, and planting in all their branches.

It has been the endeavour of the author, as he informs us in the preface, to make the manual a book of reference for the practical man as well as a text-book for the use of students. With this end in view, the information given on each subject has been made as complete and compact in itself as possible, thus obviating the necessity of cross references. In adapting the work to serve this double purpose, the author has exhibited a great amount of skill in the selection, treatment, and arrangement of the information given under the various headings.

NATURAL HISTORY OF COMMON ANIMALS.

The Natural History of Some Common Animals. (Cambridge Biological Series.) By Oswald H. Latter. Pp. x + 331. (Cambridge: University Press.) Price 5s. net.

THIS is an excellent book, written by a man who is equally in his element whether he writes as an outdoor naturalist or as a laboratory student. This combination is by no means a common one, and it is just the combination that is wanted for a book of this kind.

The common animals chosen are earthworms and leeches, the crayfish, the cockroach and its allies, dragonflies, wasps, the fresh-water mussel, snails and slugs, frogs, toads and newts, and some common internal parasites of domestic animals. The treatment of the "earthworm" is first rate. Its structure is well described, and always as the structure of a live animal, the function of each part being never lost sight of. For instance, the use of the setæ in locomotion is made clear, and the simple experiment of putting the earthworm on a polished horizontal surface is suggested. The familiar phenomenon of earthworms appearing on the surface of the soil after heavy rain is explained, and, no less successfully, what is less familiar, their method of coping with bacteria.

The "crayfish" seems to be the least successful of the papers. Only twenty-two pages are allowed to it, and of these five and a half are devoted to a discussion of the function of the otocysts. There is no lack of interest in the five and a half pages, but much that has been omitted might have claimed precedence. There is little about the appendages, from the swimmerets to the eye-stalks—a field rich in interest to the evolutionist. When the work of the scaphognathite is described, a parenthetic explanation, not easy to understand without previous knowledge, of what the scaphognathite is has to be inserted.

With insects Mr. Latter is thoroughly at home. He has made a great many observations of his own, and he has read the literature of his subject, so that he is able to give the best of what has been discovered. The result of reading his account of the wasp and its mode of life is that one wishes to read more. He has much to say about its sting, its "homing" faculty, its parasites. He enters equally into the life of the fresh-water mussel and its young glochidia sticking to fish and trailing after them. In the maw of a fresh-water mussel were found, among other things, a number of rotifers, a very interesting fact, especially

to one who has long tried to discover what preys on these small succulent creatures. Those that are bigger of build prey upon the smaller, and a large infusorian will swallow a small rotifer, but the fresh-water mussel is a giant who devours great and small impartially.

The paper on snails and slugs is good throughout, and might with advantage have been extended beyond the thirty pages allotted to it. The want of space is due to the attempt to make the book useful to the systematist and the collector, as well as to the observer and student of the lives of animals. No less than eleven pages are devoted to the definitions of the different species of British land and fresh-water gastropods, and, after all, they are too brief to be of much use to the collector. Why, then, insert them at all? In the same way no less than eight pages are expended on the specific characters of dragonflies. Where, as in the case of the British Amphibia, there are but few species, the descriptions are fuller and well suited to what I take to be the aim and purpose of the book, viz. to help and encourage the genuine student and observer as distinguished from the mere collector. Altogether the book is an admirable one. Though the waste of space which has been pointed out is to be regretted, it does not interfere with the excellence of the rest. The illustrations, fifty-four in number, are good.

F. W. H.

OUR BOOK SHELF.

The Purification of Sewage. By S. Barwise, M.D., B.Sc. Pp. xiv+220. (London: Crosby Lockwood and Son, 1904.) Price 10*s.* 6*d.* net.

THE author has in the present edition attempted to bring the information available upon this important subject up to the present state of knowledge and practice, and he has added to the former edition an appendix in which the processes in common use for the chemical examination of sewage and sewage effluents are briefly described. The work bears evidence that it has been written by one who is in touch with the practical side of the recent methods of sewage purification; the text also indicates considerable acquaintance with the advances which have been made in the treatment of sewage in various centres of population in this country.

The matters dealt with briefly but usefully include:—the nature, varieties, and chemical nature of sewage; pollution of rivers by sewage; and the treatment of sewage by land, by precipitation, and by the "septic tank," followed by either the intermittent or the percolating bacteria bed. These processes are illustrated by good reproductions of photographs, and by sectional and diagrammatic drawings. The appendix on chemical processes of analysis is also illustrated, but the directions are such as can only be usefully followed by one who has received a training in chemical analysis.

The book will undoubtedly be of use to those who are responsible for directing and advising on the treatment of sewage. The information furnished, as a whole, is reasonably accurate and up-to-date, but there are portions of the book in which the author appears to show lack of information of published results. Thus his statement on p. 125 of the relative advantages of intermittent and percolating beds leaves out of consideration the very potent aëration of the intermittent bed by the process of gaseous diffusion, since results published by the London County Council show that even at the bottom of a twelve-foot bed a fair proportion of oxygen was present in the interstitial air; he also appears to hold the opinion that such a bed has a serious tendency to become choked, which is not noticed in properly worked beds; and he speaks of four feet being "the maximum efficient depth" for such a bed, when he should know that a 12-foot bed has been worked with entirely satisfactory results. In these and in other respects the intermittent bed appears at an unfair disadvantage with the percolating bed. It should be understood that these two methods of subjecting sewage to aërobic purification are at present under trial, and as a verdict is still scarcely obtainable, a cautious statement of their relative merits is desirable.

Physiologie des Menschen. By Dr. Luigi Luciani. Ins Deutsche übertragen und bearbeitet. By Dr. Baglioni and Dr. Winterstein. Erste und zweite Lieferungen. Pp. vii+322. (Jena: Fischer, 1904.) Price 4 marks each.

THIS translation into German of Luciani's text-book of physiology aims at occupying an intermediate position between the student's text-book and the larger handbooks, being more complete than the former and less encyclopædic than the latter. The translators have brought the book up to date by additions summarising more recent work.

The present first two parts of the work, which is expected to extend to twelve parts, deal with general or cellular physiology, the physiology of the blood and circulation, and the physicochemical phenomena of respiration.

Very interesting and complete accounts are given of the mechanism of the heart beat, and of the physiology of the cardiac muscle and nerves, to our knowledge of which the author himself has added much. The detailed description of practical methods has been wisely printed in smaller type.

Useful summaries of the chief sources of the literature of physiology are given at the close of each section.

A special feature of the work lies in the excellence of the historical introductions to the sections dealt with. The account of the discovery of the circulation is exceptionally complete and interesting.

So far as one can judge from the two parts already published, the difficult task of the collection of facts and their fusion into an interesting whole has been carried out with admirable skill, and the text-book promises to form a most useful and philosophic presentation of the chief facts of physiology. The author and translators are to be congratulated on the production of a work which is distinguished not only by its mastery of detail, but by its eminently readable character and attractive literary form. The appearance of the later parts will be looked forward to with much interest.

Kritische Nachträge zur Flora der Nordwestdeutschen Tiefebene. By Dr. F. Buchenau. Pp. vi+74. (Leipzig: W. Engelmann, 1904.) Price 1*s.* 6*d.*

THE "Flora der Nordwestdeutschen Tiefebene" was published in 1894, and was well received. Since that time the author has personally, and with the help of other botanists, collected a number of new localities for plants enumerated in the flora, and new plants have been discovered. As the publishers could not at present undertake a second edition, Dr. Buchenau has prepared this small pamphlet, which forms an appendix. It contains a full numbered list of all the species of the area, but diagnostic characters are given only for new species or varieties, and the additions and eliminations are tabulated at the end of the book.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Radio-activity and London Clay.

I venture to think your readers may be interested in the following results.

The recent tube operations in London have brought to the surface specimens of the London Clay from different districts. Samples of this clay taken from such different points as Hyde Park Corner, Brompton Road, and Haverstock Hill have been tested in the physical laboratory of the South-western Polytechnic for the presence of a radio-active gas by Mr. H. Cottam, and he has been unable to detect with his apparatus any marked quantity of active gas from the clays.

With the same apparatus he has detected quite easily the radio-active gas from the water of a deep well, belonging to Messrs. Eastman, Latimer Road, W., which goes below the clay to the greensand. We have come to the conclusion that the London Clay forms a floor through which the radio-active gas does not penetrate; or it may be said that the radio-active substance only travels when the water with which it is associated can travel. This is an argument in support of Prof. J. J. Thomson's view, that the radio-active gas, which he found in deep well waters, arises from the splitting up of a trace of soluble radium salt which comes up with the water. S. Skinner.

South-western Polytechnic, Chelsea.

Cecil's Gas Engine.

The earliest practical gas engine appears to be unknown to the leading writers on internal combustion engines. I think that it may be a matter of interest to those who are antiquarians in their subject—as Maxwell used to say—to know that a working gas engine was shown in Cambridge in the year 1820. It was the invention of the Rev. W. Cecil, fellow of Magdalen College, Cambridge. A full account of his engine is given in vol. i., p. 217, of the *Proceedings* of the Philosophical Society of Cambridge (paper read November 27, 1820). The paper is long, and contains excellent matter; a new form of parallel motion is described, and what the author calls "ardent spirit" and turpentine, and vapour of oil, are suggested as possible substitutes for the gas employed by the inventor of the engine. F. J. Jervis-Smith.

Trinity College, Oxford, September 29.

The Iris and the Colour Sense.

Mr. Vincent Napier's communication in your issue of September 1 on "Adaptive Colours of Eyes" moves me to record an observation which I have never seen formulated. It is that persons who exhibit a fondness, in dress, for striking colours, or display exceptional taste in colour combination, have eyes of a pronounced and positive colour. One naturally notices this chiefly in women, but I believe it holds good for men also. In the matter of harmonious costuming, perhaps it would not be too much to say that many women dress conformably to the tint of the iris.

New York, September 17. W. P. G.

Electrolytic Oxidation.

I notice with interest that in your issue of September 22 (p. 511) a brief account is given of a memoir published by Paterno and Pannain in the *Gazzetta* on the electrolysis of alkaline aqueous solutions of potassium cyanide. The chief result of their work appears to be the production of potassium cyanate. In the summer of 1899 a friend and I were working in the same direction. From the commencement of our experiments, on both aqueous and semi-alcoholic solutions of potassium cyanide, we were struck by the almost entire absence of oxygen in the electrolytic gases. The aqueous solutions became strongly alkaline and ammoniacal. The semi-alcoholic solutions became strongly alkaline, but not ammoniacal. Acetamide was, however, detected in a distillate, the presence of which may explain the absence of free ammonia. The alcoholic solutions also yielded, on evaporation, white crystals, which proved to be potassium carbonate.

We therefore assumed, without direct proof, that oxygen had been absorbed by the potassium cyanide to form potassium cyanate. This assumption, which now receives confirmation, was based on the detection of its hydrolytic products, which we considered to have been formed according to the following equation:—

$$KCNO + 2H_2O = KHCO_3 + NH_3.$$

It is possible that continued electrolysis would have led to the production of potassium formate from the bicarbonate (*Berichte*, xxxvii., 2836), if this change had not, to some extent, already occurred.

We obtained evidence of the formation of more complex bodies, but have been unable, up to the present, to prosecute further experiments. Herbert A. Kittle.

Leatherhead, Surrey, September 26.

DEVELOPMENTS OF THREE-COLOUR PHOTOGRAPHIC PROCESSES.[1]

I.

In reviewing the recent progress of the various processes, direct and indirect, of the reproduction of colours by photography, it is obvious that there is no very remarkable advancement to report. The ultimate aim of those who do fundamental work at this subject is to formulate a method that shall automatically reproduce the colours of the original, just as by means of a camera and lens the form of the original is automatically drawn in true perspective. The realisation of this desideratum does not seem at hand. There is no method of producing colour prints known that does not need so much control in the working of it or alteration of its results, that it would be incorrect to regard the final products as simple photographs. The skill and sometimes the taste of the operator, and the nature of the appliances that he makes use of, have an important effect upon the work. This fact may lead to the idea that photographic methods of colour reproduction are of little use. But by the aid of photography results may be obtained that were impossible before, either in their character or in the economy of their production. Photography in portraiture is not considered useless because the negative goes through the hands of the retoucher.

Of the direct methods of heliochromy, the interference method that was practically worked out by Lippmann remains nothing more than an interesting illustration of certain physical phenomena. The many restrictions that limit its applications and the difficulties that beset its practice are such that it can never be expected to develop into a practical process. After a dozen years or so, Lippmann photographs are still regarded as curiosities, and are interesting only as examples of the method. None appear to have been made for the sake of the subject. The restrictions as to size and the angle under which they must be viewed, the need for getting rid of reflections from the surface of the film, the slowness of their production, and, above all, the uncertainty of the colours produced and the fact that they change with any alteration in the condition of the film, render the process useful to the physicist rather than the photographer.

The only other method of direct colour photography that appears at all likely to develop into a practically

[1] "The Water-Colour Drawings of J. M. W. Turner, R.A., in the National Gallery." By T. A. Cook. Pp. vi+86 and 58 plates. (London: Cassell and Co., Ltd., 1904.) Price 3 guineas net.
"Three-Colour Photography." By A. F. von Hubl. Translated by H. O. Klein. Pp. 148. (London: A. W. Penrose, Ltd., 1904.)
"Photography in Colours." By R. C. Bayley. 2nd edition. Pp. 151. (London: Iliffe, Ltd., 1904.) Price 1s. net.

useful process, that is, a method in which the coloured image that falls upon the prepared surface produces on it its own colours at once, is that suggested about twenty-five years ago by Charles Cros. The receiving surface is coated with a red, a yellow, and a blue dye of suitable tint, each of which fades quickly when exposed to white light. As it is the light that is absorbed that causes the fading and not the reflected light, on exposure to light of any given colour the only dye or dyes that remain unbleached are those that reflect the same colour as the incident light: a red light, for example, causes the yellow and blue dyes to fade, but not the red, and this colour therefore remains in those parts upon which it impinges. The primary difficulty is to prevent further change in the resulting picture, for the very essence of the process consists in the fugitive nature of the dyes employed. This principle of work has recently engaged the attention of several investigators, but no satisfactory method has yet been arrived at.

All practical methods of colour photography, that is, methods that are practised for the sake of the results that they furnish, are indirect. The light from the coloured object does not produce colour at all. By dividing the light into three suitable parts or colours each may be photographed separately so as to give a record of the distribution of its own colour, and by the use of these records a compound print may be made with three suitable colours. Three colours are used for the same reasons that led to the theory that the normal eye can distinguish only three colours—the three colour sensations—all the vast variety of tints being due to the excitation of one or more of these simultaneously and in due proportions. Although it has been proved that three colours are sufficient, four, and even five, have occasionally been used to overcome the difficulties of the simpler method. But none of these methods must be confused with the procedure in chromolithography, in which a dozen or more colours may be used, their choice being chiefly, if not entirely, empirical.

If any two or all three of the colour sensations are excited to the same extent, the same colour effect will be produced whatever the character of the light that causes the excitation. Therefore, the fact that two colours are not distinguishable from each other by the naked eye is no proof that they are really the same; spectroscopic analysis of the two coloured lights may reveal a great difference between them. In reproducing colour by photography, therefore, it is not necessary (and not often possible) to reproduce the original colours; it is sufficient to produce a colour that the eye cannot distinguish from the original, that is, one that affects to the same extent each of the three sensations. It was by the application of this principle that Ives worked out the essential conditions for his chromoscope. It has been stated that Ives's actual apparatus does not illustrate this principle as completely as has been claimed, but whether this is so or not does not affect the principle itself nor the usefulness of it.

The conditions obtaining in Ives's chromoscope, and in the method of making coloured transparencies (or lantern slides) which Sanger-Shepherd has made a commercial success, are the two simplest illustrations of three-colour photography. In the first case the three lights are added, for each is transmitted to the eye independently of the others, while in the second case the colours are superposed and the light that passes is only that which is absorbed by neither of the three. In the first case the result is the sum of the transmitted lights, while in the second it is the sum of the absorptions that has to be considered. Practically speaking, though not quite actually, the colours used in the second case have to be complementary to those in the first case. The first thing to be done is to settle on the three fundamental colours. Ives and others have sought to follow the three-colour sensation spectrum curves founded on the Young-Helmholtz theory of colour, as drawn by Clerk-Maxwell and later by Sir William Abney. Colonel A. F. von Hübl, in his "Three-Colour Photography," just published in English (translated by Mr. H. O. Klein), arranges a diagram in which the normal spectrum forms a circle with purple between the violet and red, white being at the centre of the circle, and the remainder of the space being filled with whitish tints of the periphery colours. He says that an infinite number of systems of three theoretically correct fundamental colours may be selected by taking any three that are 120° distant from each other. But as blue is the darkest colour it must be one of the three fundamentals, and, of course, red and green follow. Hübl asserts that Ives's curves are entirely different from those which the theory of Helmholtz requires, and are based on Maxwell's colour-mixing experiments, in which three spectrum colours were assumed as fundamentals. Hübl, by means of a similar diagram, but with black (total absorption) at the centre, finds the three fundamental colours for superposition. "Three narrow-banded colours, situated in the colour circle at 120° from each other, form a suitable colour system for trichromatic printing, and a great number of such theoretically possible systems can be ascertained." But here again we are limited to one system. As "yellow cannot be produced by pigment mixtures . . . this colour must form one of the fundamental colours." "The yellow must be absolutely correct and must not be of a reddish tint," or any neutral pure yellow would be missing in the print. Both methods, therefore, in both cases give no choice for a perfect system, and the practical results as obtained by those who have worked them out on these rather different plans are very similar.

But it is not simply a matter of dividing the light into three suitable parts. The object of the division is to get a photographic record of each, and as no photographic plate yet made has a sensitiveness to various colours proportional to their brilliancy to the eye (or rather will give densities by exposure and development proportional to these brilliancies), the colour screens or filters that divide the light into the selected fundamental parts have to compensate for the deficiencies of the plates used. Now, this compensation can only be done by reducing the light that produces an excessive effect; it therefore always leads to the necessity for a lengthened exposure. Practically, a lengthened exposure means a more costly procedure, if only because, for the same capital outlay in apparatus and accommodation, less work can be done in a given time. But, even disregarding such considerations as these, ordinary plates are so little sensitive to red that it would be hardly possible to get a photograph on them of the red image, because the very protracted exposure would give the opportunity for all sorts of interfering circumstances to produce their characteristic errors. The sensitising of the plates to be used for the green and red elements becomes, therefore, an essential part of the procedure. About two years ago, Dr. Miethe, of Berlin, showed some results of three-colour work that attracted considerable attention, the superiority of which was partly due to the use of ethyl red, a cyanine derivative, instead of the cyanine invariably used until then. Plates treated with this sensitiser give with the prismatic spectrum an almost even density from nearly C to the violet, the deficient sensitiveness in the green that most sensitisers (including cyanine itself) give being hardly appreciable. Last year a still better sensitiser was introduced, namely, "orthochrome T," and a few months ago this was found to be surpassed by

"pinachrome," both these being cyanine derivatives. Dr. E. König, who has investigated the comparative merits of these three sensitisers, states that if the sensitiveness conferred by ethyl red to red light is regarded as 100, "orthochrome T" gives a sensitiveness of 160 to 180, and "pinachrome" 450 to 500. But the density that the best of these sensitisers gives on development in the red and green of the spectrum is not proportional to the luminosity of these colours, therefore the exposure for these colours has to be longer than for the blue, but only about three times as long.

Theoretically perfect colour screens or filters are therefore useless, because a perfect plate, so far as the interpretation of colour is concerned, has not yet been produced. The colour screens and plates must be tested together, and for this purpose it is necessary to have recourse to the spectroscope, making photographs, of course, under the various conditions. But spectroscopic results are so liable to deceive observers who are not thoroughly accustomed to such work that less discriminative methods of testing are generally preferred. The colour sensitometric methods that Sir William Abney has done so much to perfect are often employed for this purpose. A series of small pieces of suitably coloured material are arranged in such a manner that when the plate is exposed through its screen and this sensitometer a definite and easily recognisable result will be obtained if the plate and screen are mutually correct. Or the colours may be arranged on a rotating disc concentrically with a grey produced by the mixture of definite proportions of black and white, so that the colour and the grey will give an equal density in a photograph of it taken in the camera through the screen on the plate. Colonel Hübl, in the volume above referred to, gives a colour chart that consists of small patches of nine pigments, with the results that should be obtained when this is photographed, using the given plate and each of the three colour screens in turn. To facilitate the use of the chart, an extra copy is provided in a pocket on the cover of the book. A grey scale of different shades, made on platinum printing paper, is exposed and developed with the colour chart, and the three prints should show this grey scale alike, when the differences due to the colour screens should be as shown in the three prints supplied.

Chapman Jones.

(*To be continued.*)

REFLEXIONS IN WATER.[1]

THERE are few studies more fascinating than that of the reflexions formed naturally in the sea, and in rivers and lakes. In the first place, this study is naturally pursued in the open air; further, the effects observed are often of surprising beauty; and lastly, most, if not all, of the phenomena observed can be explained in accordance with a few simple principles, so that it is possible for almost anyone possessing a trained faculty of observation to add to our knowledge in this direction. In writing a book on reflexions in water, Sir Montagu Pollock has entered an almost untrodden region within the borders of both art and science; with the exception of some passages in the works of Mr. Ruskin, it would be difficult to refer to any other work dealing with the same subject. It is no small accomplishment to produce a book in which so many intricate effects are traced to their causes, using language

Fig. 1.—*Old Harbour Side, Scarborough.* From "Light and Water."

[1] "Light and Water: a Study of Reflexion and Colour in River, Lake, and Sea." By Sir Montagu Pollock, Bart. Pp. xii+115; with 39 plates and 28 explanatory figures. (London: George Bell and Sons, 1903.) Price 10*s.* 6*d.* net.

of the simplest, and yet sacrificing nothing in the way of accuracy and clearness; and, although the book was written to aid artists in their study of nature, it will none the less be welcomed by men of science and those amongst the general public who attach importance to accurate observation.

There are some artists who make no secret of their disdain for scientific methods as an aid to their work; but even these, on reading Sir Montagu Pollock's book, will be forced to admit their indebtedness. Some sort of scientific method is indispensable for accurate observation of reflexions in water. Even reflexions in still water differ from what would be expected by an untrained observer; the reflected image is indeed generally a counterpart of the object, but it not uncommonly presents an entirely different aspect. Many striking instances of this are discussed and explained in the first chapter; one of the most remarkable is afforded by the reflexion of a rainbow in a lake, which is really the image of a bow quite distinct from the one seen directly. When we come to the study of reflexions in rippled water, further complications arise; in the second chapter, the reader is led on from the most simple and elementary facts to appreciate and understand complicated effects such as are reproduced in the accompanying illustration (Fig. 1). In such cases some amount of scientific training is absolutely necessary to one who would give a faithful pictorial representation of nature; for the appearance presented changes every instant, and without the aid of some sort of clue one can scarcely avoid obtaining inharmonious effects. But even in still water, where there is no incessant change to distract the attention, there are yet many opportunities for the artist to go wrong; without a very accurate knowledge of fundamental principles, it would be impossible, for instance, to deduce the nature of the reflexions shown in Fig. 2 from the actual appearance of the objects reflected. Notice, for instance, that while the reflected image of the spire of the distant church is seen, the body of the church and the dark hill behind it are not present in the reflexion; there is even no image to be seen of the shore between the church and the water.

The third and fourth chapters are devoted to a study of the colours in still and rippled water. This part of the subject is exceedingly complicated, and it is difficult to make any general statement which will help us to predict the exact colours to be seen under given conditions. The observed colour of the water is due, partly to light reflected from the surface of the water; partly to light scattered by minute particles floating on the surface; partly to the inherent colour of the water, modified, maybe, by the presence of fine suspended particles; partly to the colour of the stones, sand, or mud at the bottom of the water; and, lastly, the whole effect is complicated by "contrast," which may modify greatly the various colours observed. For instance, standing on one of the cliffs of Sark, and looking out over the sea, the latter often appears of a vivid green, dappled here and there with patches of intense purple. Careful observation shows that the purple patches mark the

FIG. 2.—Sils Baseglia, Upper Engadine. From "Light and Water."

sites of submerged beds of sea-weed; but the weed is not itself purple, but of a dark olive-green colour, so that the colour of the patches is not easily explained. The most probable explanation appears to be as follows:—The sea-water is itself blue, *i.e.*, it is relatively opaque to red and partly opaque to yellow light. Yellow light is most copiously reflected from the sandy bottom of the sea, so that, on the whole, the greater part of the light reflected from the bottom of the sea which reaches our eyes is green. The beds of sea-weed merely act as general absorbers, and would give rise to dark patches were

it not for the effect of contrast; it is well known that a grey object lying on a vividly green ground appears to be of a reddish or purplish hue. It may here be remarked that this phenomenon yet awaits explanation; it was at one time thought that the eye insensibly travelled over the green expanse, the green colour sensation became fatigued, and faint white light afterwards provoked the complementary sensation. It has been found, however, that the same colour phenomena are observed when the illumination is instantaneous, so that this theory falls to the ground.

Finally, it may be stated that Sir Montagu Pollock's book is throughout of absorbing interest; the excellence of the illustrations can be inferred from an inspection of those used to illustrate this short notice, and the printing is everything that could be desired.

Edwin Edser.

NOTES.

We understand that the second International Wireless Telegraph Conference, which was to have been held in Berlin on October 6, has been postponed until next spring. It will be remembered that the Wireless Telegraph Act which was passed at the end of last session was rushed through the House partly that the Government representatives might have a better basis for making agreements at this conference. It is stated that a considerable number of applications for licences under this Act have been received by the Postmaster-General. Some of these applications come from the submarine cable companies.

The funeral of Prof. Niels Finsen at Copenhagen on September 29 was attended in person by King Christian, King George of Greece, Queen Alexandra, and all the other Royalties now in Copenhagen, as well as by the Danish Ministers of State, members of the Diplomatic Corps, the president of the Danish Parliament, the Burgomasters of Copenhagen and the chief provincial towns, and numerous representatives of foreign scientific institutions, universities, and societies. King Edward was represented by the British Minister, Sir W. E. Goschen. A number of Danish medical men have issued an appeal for the erection of a monument to Prof. Finsen by voluntary contributions.

A new association, the Institute of Hygiene, has been formed having for its object the dissemination of knowledge on the subject of personal and domestic hygiene. It aims to be self-supporting, and in order to accomplish this has organised a permanent exhibition of hygienic products and appliances, *e.g.* foods, clothing, filters, stoves, &c., open free to the general public, and a special section devoted to drugs and medical and surgical appliances to which medical men alone are admitted. The revenue gained from the rents paid by exhibitors will be devoted to educational work, which will take the form of local lectures, with examinations and certificates. The exhibition, which was formally opened by Sir Joseph Fayrer on September 30, is housed at 34 Devonshire Street, W.

A visit by a party of French physicians and surgeons is about to be paid to London. The party is to arrive on October 10, and will comprise some 150 gentlemen. A committee, of which Sir William Broadbent is president and Sir Thomas Barlow treasurer, has been organised to make arrangements for their reception and entertainment, Dr. Dawson Williams and Dr. Jobson Horne being the honorary secretaries. They will be entertained at a banquet at the Hotel Cecil on October 12.

Prof. Koch has retired from the post of director of the Institute for Infectious Diseases at Berlin owing to the increasing demands which other bacteriological work make upon his time and energies. The Berlin correspondent of the *Times* states that in the course of the winter Prof. Koch will proceed to German East Africa in order to continue those studies of tropical and other diseases which he had not completed during his recent visit to Rhodesia. In particular he will continue to investigate the part played by ticks in conveying the infection of various cattle diseases.

A conference on agricultural education will be held in the Shire Hall, Gloucester, on Saturday, October 15, under the presidency of Sir John Dorington, M.P. At the morning session Lord Onslow will deliver an address, and the other speakers will include Sir W. Hart Dyke, Prof. T. H. Middleton, and Lord Monteagle. At the afternoon session Sir T. Dyke-Acland, Sir John Cockburn, Mr. A. D. Hall, and others will address the conference.

The deaths are announced of Prof. E. von Martens, vice-director of the Berlin Zoological Museum, and Dr. P. van der Vliet, formerly professor of physics at the University of St. Petersburg.

The Physico-Mathematical Society of Kazan has awarded the Lobatchewsky prize to Prof. D. Hilbert, of Göttingen, for his book on "Die Grundlagen der Geometrie" and other researches. The Lobatchewsky gold medal has been conferred on Prof. Poincaré, and Profs. Mansion, Laisant, and Peano have been elected honorary members of the society.

The twenty-fifth annual "Fungus Foray" of the Essex Field Club will be held on Saturday, October 15, at High Beach, Epping Forest. The referees will be Dr. M. C. Cooke and Mr. George Massee, of the Kew Herbarium. Mr. Massee will read a paper on some diseases of trees. Any botanists wishing to attend should communicate with the secretary, Buckhurst Hill, Essex.

Prof. Fehr, of Geneva, editor of *L'Enseignement mathématique*, is circulating among mathematicians an inquiry form containing a number of questions relating to their manner of working. These questions refer to such points as when and where the mathematician answering them acquired his taste for mathematics, whether his researches are suggested by the study of mathematical literature or the ideas come to him spontaneously, whether he publishes his ideas immediately or leaves them for a time, whether he observes regular rules in his living, whether he finds the morning or evening best for work, and so forth. The answers are to be analysed by Prof. Th. Flournoy and Dr. E. Claparède, both experienced psychologists.

The system of "normal piling" which forms the basis of Prof. Osborne Reynolds's "Theory of the Universe," is discussed by the late Prof. J. D. Everett in the *Philosophical Magazine* for July. In the review of Prof. Reynolds's work, which appeared in Nature, attention was directed to the fact that the arrangement of spheres consistent with minimum volume is not unique. Prof. Everett's paper states that every system of maximum compactness consists of parallel tiers in triangular arrangement, but each tier can be fitted over the one below in two ways. When two tiers have been placed the piling will be normal if the spheres of the third tier are *not* vertically above those of the first; but another arrangement, giving rise to what Prof. Everett called *antinormal* piling, may be obtained by placing the third tier in the spaces above the first.

Among recent contributions to aëronautics, considerable interest attaches to Mr. A. F. Zahm's paper on atmospheric friction, published in the *Bulletin* of the Philosophical Society of Washington, xiv., pp. 247–276. It is commonly assumed by experimenters that skin friction in ordinary gliding models is a negligible quantity, but Mr. Zahm finds that the frictional resistance is not improbably as great for air as for water in proportion to their densities, and, indeed, that it constitutes one of the chief obstacles to bodies and aërosurfaces gliding at high speeds. By plotting the relations between velocity and resistance on logarithmic squared paper, the author found for plane surfaces that the frictional resistance varied as the power of the velocity with index 1·85. Prof. M. Smoluchowski-Smolan, in his paper in the *Philosophical Magazine* for June on the principles of aërodynamics, discusses the equations of motion of a compressible fluid when account is taken of thermodynamical effects, and he applies the principle of dynamical similarity to certain physical problems. The *Scientific American* for September 10 contains two illustrations of gliding machines. The idea of attaching a machine to a bicycle in order to attain the requisite speed has doubtless frequently suggested itself to experimenters, and Mr. S. V. Winslow contributes a photograph of a "bicycle aëroplane," which he alleges "has proven perfectly successful so far as balancing is concerned." The figure of Prof. Botts's circular aëroplane, furnished with vertical screws in the centre, reminds one of the illustrations in the well known "Histoire des Ballons" of Tissandier, and it may be safe to predict that a small model of this pattern would constitute a pretty toy, and would sail well through a room.

In the *Journal* of the Royal Microscopical Society for August, a simple direct proof of Abbe's theorems on the microscopic resolution of gratings is given by the late Prof. J. D. Everett, F.R.S.

In the *Physical Review* for July Mr. N. A. Dubois describes a simple method of employing allotropic silver for the preparation of conducting fibres for quadrant electrometers and other similar apparatus. The author finds that dried films of allotropic silver, although poor conductors, become very good conductors on being treated with gaseous hydrochloric acid, and that the method can be applied to the most delicate apparatus in a few minutes without risk of injury.

Messrs. E. L. Nichols and E. Merritt describe some interesting studies on fluorescence in the *Physical Review*, xix., 1 (July). The authors found that eosin, naphthalin roth, fluorescein, quinine sulphate, chlorophyll, canary glass, green and white fluorspars, and other substances exhibited the same types of fluorescence, the spectrum consisting of a single band near the infra edge of the corresponding absorption band. The position of the maximum and the distribution of intensity was independent of the wave-length or composition of the exciting light. Fluorescence near the red or violet ends was traceable further towards the opposite end than is the case with bands near the middle of the spectrum, because of the increased luminosity in these directions. In no case did Stokes's law hold. Fluorescent substances having absorption bands of shorter wave-length than that with which fluorescence was associated were excited by light in that band, but the same was not the case when the wave-length was longer. Finally, where more than one fluorescence band existed, it was considered probable that each was due to a different fluorescent material, as no case of multiple fluorescence occurred where only one fluorescent substance was present.

The first two numbers (July and August) of a new magazine—*Le Radium, La Radioactivité et les Radiations*—received from MM. Masson and Co., Paris, contain many useful and interesting articles on radio-activity and allied subjects. These articles are not original contributions, but are readable and well illustrated accounts of very recent original work. Several deal with recent attempts to use radio-active bodies for therapeutic purposes. There are in addition reviews of recent papers, notices of new books, and a correspondence column. While such a magazine may not be essential to those who are able to keep in touch with the recognised scientific journals, it will probably be found useful by many interested in the subject.

The meteorological observations and results relating to the Bremen Observatory for 1903 have been published by Dr. Paul Bergholz. The volume forms one of the series of the *Deutsches meteorologisches Jahrbuch*; it therefore follows that the work leaves nothing to be desired. The tables show the actual readings at three hours daily, with monthly and yearly means, and daily means for each hour. In addition, there are phenological and other observations for Bremen, and rainfall summaries for several stations in connection with the observatory.

We have received the report on rainfall registration in Mysore for 1903, by Mr. J. Cook, director of meteorology in that province. The number of Government stations is 194. In addition to the tables, the report includes useful maps showing average monthly, yearly, and geographical rainfall for thirty-four years (1870–1903). During 1903 some heavy falls in twenty-four hours are recorded:—11 inches in the district of Shimoga, in July; 11·5 inches in Kolar, in November; 12·65 inches in Kadur, in July. Mr. Cook states that a station which escapes inspection even for a single year is most likely to be defective in some particular; a yearly inspection would obviously entail a large amount of expense in travelling, and its necessity would seem to point to want of interest by the observers in their work.

We have received a copy of a second edition of Mr. Conway Belfield's "Handbook of the Federated Malay States," which has just been published. The book has been thoroughly revised, and the statistics brought down to the end of the year 1902.

Prof. J. Cvijić contributes to the *Mitteilungen* of the Vienna Geographical Society an important paper summarising the results of recent research on the glacial phenomena of the Balkan peninsula, and correlating them with the results of similar investigation in the Alps and Carpathians.

We have received the third *Bulletin* of the International Council for the Study of the Sea, containing the observations made during the cruises of the different vessels in February, 1904; also No. 14 of the council's *Publications de Circonstance*, on surface temperature observations in the North Sea, by Dr. Evan Everdingen and Dr. C. H. Wind.

A series of gazetteers of the States is being published by the U.S. Geological Survey. During the last few weeks gazetteers of Virginia, Maryland, Delaware, and Texas have appeared, each giving a general description and an account of special features. Another valuable publication of the same department is a third edition of the *Bulletin* on the "Boundaries of the United States and of the Several States and Territories."

The Central Meteorological Observatory of Japan has issued the first of a new series of *Bulletins*, in which it is

intended to publish the results of researches on meteorology and allied sciences made by members of the staff of the observatory. The present *Bulletin* contains valuable papers on earth temperature at Tokio, the mean annual temperature of the surface of the sea in the Western Pacific Ocean, the epochs of the first ice in Japan for 1902, and evaporation in Japan.

A valuable contribution to the theory of oceanic currents is made by Prof. Otto Pettersson in a paper on the influence of ice-melting upon oceanic circulation, published in the September number of the *Geographical Journal*. Prof. Pettersson describes the results of some remarkable experimental work, and gives an account of recent theoretical inquiries by himself and others, applying the results to the elucidation of the complex circulation in the Norwegian Sea and the north polar basin. An interesting point is the suggestion that the problem of forecasting the monsoons of India may ultimately be solved by a systematic survey of the hydrographic conditions in the Indian Ocean.

The analyses given in the Jamaica *Bulletin* of the Department of Agriculture (August) testify to the purity of the native sugars, but where the sugar is required for preserving fruit the addition of an antiseptic is found to be necessary in order to prevent infection with Torula. Experiments are being made with calcium bisulphite.

More than a dozen fungi have been recorded as destructive parasites on vine-roots, and to these an addition has been made by Dr. Istvánffi, who describes in the third volume of the *Annals* of the Royal Hungarian Viticultural Institute how he has traced the cause of disease in several districts in Hungary to the ravages of the Gasteromycete, *Ithyphallus impudicus*.

The second part of "Plantæ Yucatanæ," forming vol. iii. of the botanical series of the Field Columbian Museum, Chicago, was issued in April, and deals with the Compositæ. The features of this work, which include only plants of the northern half of Yucatan, are the descriptive accounts, with occasional notes on native names and uses, by Dr. Millspaugh and the excellent drawings of flower and fruit executed by Mrs. Chase for each species.

The most striking features of the North American and Mexican deserts are discussed at some length in Schimper's "Plant Geography." In the *Botanical Gazette* (July) Dr. D. T. MacDougal gives an account of the expedition which he arranged to explore the delta of the Rio Colorado and that practically unknown portion of the Mexican desert which lies on both sides round the head of the Gulf of California. Amongst the xerophytes, which were found in the regions of extreme aridity, were many perennials containing latex and a large number of forms which secrete volatile oils or exude resinous gums; but plants with massive storage organs were absent, a fact which Dr. MacDougal attributes to the excessively small and even distribution of the rainfall throughout the year.

The two articles in the September number of the *Zoologist* are devoted to ornithology, Mr. F. M. Littler treating of the birds of Tasmania, while Sergeant H. Mackay, of the 2nd Highland Light Infantry, discusses those of Jersey. It is highly satisfactory to find a non-commissioned officer of His Majesty's Service studying the zoology of the district in which he happens to be quartered.

The report of the Indian Museum, Calcutta, for 1902–3, and that of the Albany Museum, Cape Colony, for 1903, are just to hand. Both institutions appear to be in a flourishing condition, although there are complaints from both of insufficient numbers on the staff to cope with the work. The registered additions to the Indian Museum during the period covered by the report numbered 2096 specimens, of which 326 were archæological and the remainder zoological. It is satisfactory to note that the Albany Museum is making strenuous efforts to secure a representative series of the large mammals of the Cape Colony and adjacent districts, its present deficiency in the smaller forms being a matter of little consequence, as these are in no present danger of extermination.

The prophylaxis of malaria was exhaustively discussed in the section of tropical diseases at the recent meeting of the British Medical Association (*Brit. Med. Journ.*, September 17, p. 629). Dr. Strachan, C.M.G., principal medical officer of Lagos, West Africa, emphasised the value of anti-mosquito measures and of the prophylactic use of quinine. Captain James and Lieut. Christophers, from their experience at Mian-Mir (see Nature, lxix. p. 467, and lxx. p. 230), doubted the universal applicability of anti-mosquito measures for the reduction of malaria. Prof. Ronald Ross, F.R.S., criticised the work and conclusions of the last named observers on the following grounds:—(1) it is doubtful if mosquito propagation at Mian-Mir was really suppressed to the extent claimed; (2) the tests employed for detecting reduction in the number of mosquitoes were not conclusive; (3) the figures given regarding the variations in the amount of malaria are inconclusive; (4) the whole experiment is open to the final criticisms (*a*) that it might not have been continued long enough, and (*b*) that the radius of operations might not have been large enough. He considered that all that the experiments proved was that after operations (*i.e.* anti-mosquito measures) extending to a half-mile radius, lasting a year and a half, and apparently costing between two and three hundred pounds, no very large reduction in the number of mosquitoes or in the amount of malaria was apparent.

Messrs. Charles Griffin and Co. have just published the sixth edition, revised and enlarged, of Mr. Andrew Jamieson's "Elementary Manual of Applied Mechanics."

Mr. Balfour's presidential address delivered before the British Association at the recent meeting at Cambridge, and printed in Nature of August 18, has been published in pamphlet form by Messrs. Longmans, Green and Co. The price of the pamphlet is one shilling net.

A cheap edition of Lord Avebury's book on the "Scenery of England" has been published by Messrs. Macmillan and Co., Ltd. The book contains nearly two hundred illustrations—many of them full-page and all instructive—and in its new form it should be the means of creating wide interest in the scientific significance of scenery.

The first volume of *Technics*—a magazine for technical students—is full of useful articles and notes on many aspects of technology. There are descriptions of institutions where the work of higher scientific and technical education is being developed, articles on the education of engineers, educational systems, designs, materials and manufactures of various kinds, photography, bacteriology, and many other departments of pure and applied science. The magazine is well illustrated, and should be of real service to technical education in this country. The publishers are Messrs. George Newnes, Ltd.

Mr. Edward Arnold announces an illustrated work on "English Estate Forestry," by A. C. Forbes.

The list of announcements of the Cambridge University Press includes:—"Mathematical and Physical Papers by the late Prof. Sir G. G. Stokes, Bart., F.R.S.," vol. v.;

"The Collected Mathematical Papers of Prof. J. J. Sylvester, F.R.S.," vol. ii.; "The Dynamical Theory of Gases," by J. H. Jeans; "The Analytical Theory of Light," by J. Walker; "A Treatise on Analytical Dynamics," by E. T. Whittaker; "Alternating Current Theory," by A. Russell, in two vols.; "The Study of Chemical Composition," by I. Freund; "The Fauna and Geography of the Maldive and Laccadive Archipelagoes: being the Account of the Work carried on and of the Collections made by an Expedition during the years 1899 and 1900 under the leadership of J. S. Gardiner," vol. ii., part iv., illustrated; "Reports of the Anthropological Expedition to Torres Straits by the members of the Expedition," edited by Dr. A. C. Haddon, F.R.S.; "Studies from the Anthropological Laboratory in the University of Cambridge," by W. L. H. Duckworth, vol. i.; "On two Orders of Arachnida: Opiliones, especially the Suborder Cyphophthalmi and Ricinulei, namely the family Cryptostemmatoidæ," by Drs. H. J. Hansen and W. Sørensen, illustrated; "Immunity in Infectious Diseases," by Prof. Metchnikoff, authorised English translation by F. G. Binnie, illustrated; "Morphology and Anthropology," by W. L. H. Duckworth; "The Origin and Influence of the Thorough-bred Horse," by Prof. W. Ridgeway; "Fossil Plants: a Manual for Students of Botany and Geology," by A. C. Seward, F.R.S., vol. ii.; "Trees: a Handbook for Students of Forest Botany," by Prof. H. M. Ward, F.R.S., in six volumes, vols. ii. to vi.; "The Morphology of Plants," by J. C. Willis; and "The Journal of Agricultural Science," edited by Prof. T. H. Middleton, T. B. Wood, R. H. Biffen, and A. D. Hall.

MESSRS. JOHN WILEY AND SONS (New York) and Messrs. Chapman and Hall, Ltd. (London), have in preparation:—"An Elementary Treatise on the Differential Calculus, Founded on the Method of Rates," by W. W. Johnson; "A Treatise on Concrete, Plain and Reinforced," by F. W. Taylor and S. E. Thompson; "Elements of General Drafting for Mechanical Engineers," by C. E. Coolidge and H. F. Freeman; "Conversations on Chemistry," by W. Ostwald, translated by E. C. Ramsay, part i.; "Machine Shop Tools and Methods," by W. S. Leonard; "Ordinary Foundations, including the Coffer-dam Process for Piers, with numerous Practical Examples from Actual Works," by C. E. Fowler; "The Textile Fibres, their Physical, Microscopical, and Chemical Properties," by J. M. Matthews; "Manual of the Chemical Analysis of Rocks," by H. S. Washington; "Untechnical Addresses on Technical Subjects," by J. Douglas; "Techno-Chemical Analysis," by G. Lunge, translated by A. I. Cohn; "Application of some General Reactions to Investigations in Organic Chemistry," by Prof. Lassar-Cohn, translated by J. B. Tingle; "Notes on Assaying and Metallurgical Laboratory Experiments," by R. W. Lodge; "Elements of Mechanism," by P. Schwamb and A. L. Merrill; "An Introduction to Projective Geometry and its Applications, an Analytic and Synthetic Treatment," by A. Emch; and "Manual of Serum Diagnosis," by O. Rostoski, translated by C. Bolduan.

OUR ASTRONOMICAL COLUMN.

THE SOUTH TEMPERATE SPOTS ON JUPITER.—In a letter to No. 348 of the *Observatory*, Mr. Denning directs attention to the need for further observations of the white spots which encroach on the south side of the south temperate belt of Jupiter.

On August 9 he saw two brilliant spots in this locality, having the longitudes 254°.1 and 290°.1 respectively, and has little doubt that these are identical with those he observed in 1903 and previously.

As Mr. Denning has suggested that the movements of these objects may cause the observed irregularities in the velocity of the great red spot—the velocity of which is a little less—it is important that they should be frequently observed, and the results of the observations published.

The spots lose about 16°.4 per month relatively to Crommelin's System ii., and their positions for the next few months will be as follows:—

		I. Long.		II. Long.
1904 Oct. 15	...	218°.4	...	254°.0
Nov. 15	...	202.0	...	237.6
Dec. 15	...	185.6	...	221.2
1905 Jan. 15	...	169.2	...	204.8
Feb. 15	...	152.8	...	188.4

Mr. Denning will be pleased to receive records of new or old observations of these objects.

A RAPIDLY MOVING SOLAR PROMINENCE.—A fairly large prominence having a great velocity was observed by Mr. J. B. Coit, of Boston University, on May 23. Whilst setting the slit of his spectroscope on Hα he noticed a cloud-like arch, made up of radial filaments, stretching from P = 89° to P = 100°, the space below the arch being apparently quite blank. At 11h. 55m. the altitude of the prominence was 90″, and it quickly increased to 105″, after which it rapidly decreased until, at 11h. 58m., it was only 70″. By this time all semblance to the original structure was lost, and only a few cloudlets remained. At 12h. 1m. nothing could be seen above the limb, and the chromosphere between 89° and 100° was quite tranquil, except for a few small shreds at the places where the ends of the arch had rested. Subsequent observations with a 5-inch equatorial showed no trace of spots or bright faculæ on or near the limb in this region (*Popular Astronomy*, No. 7, vol. xii.).

PUBLICATIONS OF THE GRONINGEN ASTRONOMICAL LABORATORY.—Two numbers of these *Publications*, which are printed in English and edited by Prof. Kapteyn, have just been received. No. 12 is devoted to the results of an investigation by Dr. W. de Sitter of the systematic differences between the photographic and visual magnitudes of stars depending upon the galactic latitude. The investigation was carried out at the Cape Observatory, Dr. de Sitter taking the photographs and Mr. R. T. A. Innes making the visual observations.

The results show, among other things, that the colours of the stars near the galactic poles seem to be distributed at random, and, further, that no *average* colour exists for those in the galaxy, but rather that there are colour differences which vary irregularly with the galactic *longitude*. This interesting result calls for further investigation, and Dr. de Sitter suggests several methods which might be employed to elucidate the matter further.

No. 13 of the *Publications* contains a catalogue of the proper motions of 66 stars of the Hyades, derived from the comparison of thirty-four catalogues published between 1755 and 1900. This work was performed by Herr H. A. Weersma to facilitate the reduction of Prof. Duner's plates, which were taken for the purpose of determining the proper motions of the Hyades stars. The results are given in detail in the paper, which concludes with a general catalogue of the 66 stars, showing their magnitudes, their positions for 1900, and their proper motions.

THE GOODSELL OBSERVATORY EXPEDITION TO THE ROCKY MOUNTAINS.—A short general description of the results obtained by Dr. H. C. Wilson and Prof. Payne during their sojourn at Midvale (Mont.), which is situated at an altitude of about 4800 feet in the Rocky Mountains, is given in No. 7, vol. xii., of *Popular Astronomy*.

The expedition was undertaken in order to photograph some of Herschel's suspected nebulous regions under exceptionally good atmospheric conditions. The heavy dews, caused by a difference of 40 or 50 degrees between the day and night temperatures, and the smoke from neighbouring forest fires somewhat interfered with the carrying out of the entire programme, but on the whole the photographs obtained were very successful. A full description of the work accomplished, the observing conditions, &c., is promised for a later publication.

Anthropology at the British Association.

The address of the president, Mr. Henry Balfour, dealt with the subject of evolution in the material arts as illustrated by the work of the late Lieut.-General Pitt Rivers, and has been already printed in full in Nature (September 1).

Evolution in the Material Arts.

The remainder of the programme on August 18 was appropriately reserved for communications which illustrated the application of the theory of evolution to special problems of art and technology, as follows :—

Prof. Oscar Montelius gave a demonstration of the evolution of the lotus ornament, which, though it brought forward no new points, gave a well illustrated survey of the work of Goodyear and others, and analysed the complicated results of the interaction of naturalistic and conventional treatments of the same original motive. The discussion which followed was mainly directed to secure recognition for other plant-motives, such as the fleur-de-lys, iris, papyrus, as being partly responsible for certain variations of the "lotus-ornament," and the inevitable skirmish followed the mention of the "Ionic capital."

Prof. Flinders Petrie's note on the entomology of scarabs distinguished five principal types of scarab-backs, designed in imitation of five genera of beetles, Scarabæus, Catharsius, Copris, Gymnopleurus, and Hypselogenia, and showed how the characteristic forms of the head, elytra, and legs of these genera have given rise to a large number of conventional variants. The use of other beetles besides the true Scarabæus, for magical purposes, is well attested both by the medical papyri and by the modern folk-lore of Egypt.

Prof. Flinders Petrie's description of his excavations at Ehnasya (Herakleopolis Magna), in Egypt, was chiefly noteworthy for his comparative study of the forms of the Roman lamps and terra-cotta figurines, which were obtained in large enough numbers to afford an intelligible series. Here, also, a very few principal types have degenerated into numerous conventional and unintelligible variations, which have often influenced each other and given rise to fresh types based on misinterpretation of the blurred forms. In this instance it is noteworthy that the older and purer forms can be proved to have survived alongside even the most corrupt; as if the latter, though well established, pursued a separate course, and failed to supplant their archetypes.

Another point of some interest in this connection is Prof. Petrie's discovery, near Ehnasya, of a modern Coptic cemetery which preserves, in its tomb-façades and enclosures, many architectural features which are characteristic of ancient Egyptian burial-places.

Mr. R. T. Günther read on August 22 a study of the *cimaruta*, a common Neapolitan charm representing in silver a sprig of rue with magical symbols appended. He brought together a large number of examples, and supplied full details of the successive developments which the originally naturalistic model has undergone, as well as of the significance of the emblems which have been added to the rue-plant to increase its prophylactic powers.

Physical Deterioration and Anthropometric Surveys.

The session of August 19 was devoted to a systematic discussion of the alleged physical deterioration of the people of these islands, with special reference to the recent report of the Privy Council Committee, and to the scheme proposed by the association's committee on anthropometric investigation for the organisation of an anthropometric bureau to collect and analyse more adequate data than those which are at present available.

The report of the committee on anthropometric investigation was read by the secretary, Mr. J. Gray. Some progress has been made in the determination of the necessary standards of measurement, and the chairman and secretary of the committee have given evidence before the Privy Council's Committee as to the data which already existed, and as to the best means of securing an adequate, continuous, and homogeneous series in future. The committee recommends a small permanent anthropometric bureau, organised as a committee of the Privy Council, with an honorary consultative body, a director and deputy director (trained, one in anthropology, the other in statistical method), and an adequate body of surveyors, male and female, who would visit schools, factories, and other institutions, and secure representative sets of measurements. An appendix to the report takes account of the surveys already in progress in Scottish schools and lunatic asylums, in London hospitals, in Dorsetshire, and among the gipsies of the Scottish border.

Prof. D. J. Cunningham, F.R.S., who is chairman of the anthropometric committee, accepted the general conclusion of the "epoch making" report of the Privy Council Committee, that there was no serious physical deterioration in the nation at large, but held strongly that without proper environment and nurture, and particularly without proper air and food, it was impossible to maintain in the coming generation the mean national standard of physique to which a people tends naturally to approximate, so far as outward circumstances permit. Slow evolutionary changes in this physical standard are taking place, but except in regard to the teeth, which are degenerating rapidly, they may be neglected in practice. The recent improvement in the physique of women of the upper and middle classes is due to healthier conditions and habits, and illustrates their effects. In spite, however, of the labours of the British Association's Anthropometric Committee in 1878–83, the evidence on which all inferences have been based hitherto is fragmentary, ill coordinated, and quite inadequate, and a systematic survey such as is now proposed would put the whole matter on a quite different footing. The cost would be slight, and the national advantage incalculable.

Dr. F. C. Shrubsall followed with a comparison of the physical characters of hospital patients with those of healthy individuals from the same areas, with suggestions as to the influence of selection by disease on the constitution of city populations. Blondes are found to suffer more than brunettes from rheumatic disorders, and less from tuberculosis, nervous disorders, and cancer. Blondes also suffer more from disease in childhood, and their numbers and proportion consequently diminish until the age of twenty to twenty-five, when the pulmonary tuberculosis of the brunettes begins rapidly to redress the balance. In cities, the most overcrowded and most unhealthy areas are consequently the most brunette, and also have the highest infant mortality through the extinction of blonde children by disease. Dr. Shrubsall's paper was well illustrated with original tables and maps, and was evidently followed with close attention.

Mr. J. Gray then explained in detail the working of an anthropometric survey, and the valuable results which may be expected from it in anthropological science, and in practical economy and hygiene. Civilisation has brought so many new influences to bear on the more advanced races of mankind that more accurate and copious observations are required to detect in their inception deep-seated changes in the relation of man to his environment, the effects of which may be controlled if recognised in time.

The president of the association, who occupied the chair in the section throughout the session, opened the discussion by the inquiry, what is the precise nature and effect of the set of circumstances which we describe as "town life"? the most important of the temporary and obvious causes of physical deterioration, as opposed to the permanent and insidious causes indicated by Dr. Cunningham. Mere want of indoor ventilation, for example, does not produce deterioration, *e.g.* in the one-room cottages of the gigantic Lowlanders of Scotland; and both sanitation and quality of food are, on the whole, better in the towns than in the country. Among the causes which might produce permanent changes in the national physique, three seemed particularly noteworthy. Since marriage is later, and families are smaller, in the middle classes than in the lower, facilities for "rising," such as are given by modern education, cannot but diminish the proportion in the next generation of the offspring of the more efficient in this. Town life, too, by encouraging a brunette population, is altering the inherited characteristics of the nation at the expense of the traits which we owe to our blonde ancestry. Further, town life, by attracting the more energetic elements in the rural population, is throwing

upon the less efficient remainder the greater part of the burden of continuing the race. Town life, however, does not seem to be among the factors which it is possible to eliminate by legislation, and it is permanently selective agencies such as this which affect the actual quality of a race.

Sir John Gorst considered it proved that a large proportion of the nation lives in conditions unfavourable to normal development, and that the race is being propagated in undue proportion by the lowest and least fit. The general death-rate decreases, for instance, but not the death-rate for infants. Legislation might fairly prohibit marriage between the immature or the mentally unfit; but the main cause of the relative increase in the low-class birth-rate is, as the Royal Commission in New South Wales has shown, the luxurious reluctance of the well-to-do to take their share in bringing up the next generation. Meanwhile, in so far as it controls any part of a child's lifetime, as it does by compulsory education, the State is so far responsible for securing it sufficient air and food. There are many ways of securing these and of coercing neglectful parents, and local authorities might well be given permission to experiment in the manner suggested by the medical faculty of Scotland in regard to the Scottish Education Bill.

Prof. Rudolfo Livi, director of the Italian Military Survey, described its methods, and replied to Dr. Cunningham's criticisms of military measurements. Conscript statistics, however, yield more representative data than those of a voluntary army, and the Italian survey establishes clearly the correlation between prosperity and enlightenment and immunity from disease. In England, probably the mitigation of extreme social conditions favoured a relatively high physique.

Mr. E. W. Brabrook, secretary of the British Association Committee of 1878–83, urged the importance of uniformity of measurements, and assured the anthropometric committee of the cooperation of existing surveys.

Major McCulloch described the survey, recently ordered, of children in army schools, and discussed practical difficulties of uniform measurements. Prof. A. Macalister insisted on the necessity for large numbers of observations. Statistical conclusions from inadequate data are fallacious.

Mrs. Watt Smyth recommended the inclusion of simple anthropometric observations in the ordinary routine of school registration as an aid to the teacher in following the development of the child. In Boston, U.S.A., such daily observation greatly diminished the risk of infectious disease. The valuable results thus attained would facilitate a full national survey.

Other papers on anthropological organisation occupied the afternoon of August 19. Mr. Edgar Thurston described the progress of the ethnographic survey in Madras, of which he has been the principal organiser, going into details as to method and cost, the nature of the evidence which it is possible to collect, both in anthropometry and in ethnography, the photographic record of racial types, and the difficulties of combined museum and field work such as are unavoidable with an infinitesimal staff working among ignorant and timid populations. He concluded with a summary of the ethnography of the area covered by the survey, and a criticism of the published measurements of the Indian Coronation contingent.

The report of the committee on anthropological teaching described the method of inquiry, and gave details of the position occupied by anthropology or its main subdivisions in some seventy-five universities and colleges in Europe, the United States, and elsewhere, with many interesting data as to the ways in which this comparatively new study has won recognition as an offshoot of this or that recognised subject, and as to the practical applications which are found to emerge wherever a more enlightened policy has permitted a museum or university to provide adequate teaching.

Mr. J. F. Tocher described in detail the recent anthropometric work in Scotland outlined in the morning's discussion, and also the distribution and variation of the surnames in east Aberdeenshire in 1696 and 1896. Migration accounts for the disappearance of many names; but the extinction calculated by Galton and Watson is found to be approximately correct, and likewise the rate of change on Karl Pearson's theory of contingency.

Anthropography.

The experiment was made on Monday morning (August 22) of a separate subsection for the discussion of papers on human anatomy and kindred subjects. The lecture room of the zoological department was kindly lent for this, and Prof. A. Macalister presided.

Dr. G. Elliot Smith made a communication on the persistence in the human brain of certain features usually supposed to be distinctive of apes, based on a large series of simple human brains, chiefly African. Simian characters are most conspicuous in the occipital region, because the visual area is as well developed in apes as in man; but though the structure is identical, the shape of this area in man is much distorted by increase of the cortical area in front of it. Simian resemblance is more often retained in the left occipital region than in the right, because in man the visual centre retracts more towards the mesial surface on the right side, and this asymmetry often influences the cranial form. Large "Affenspalten" may occur in various races, but are rarely symmetrical, except in Negro brains, which are distinctly more pithecoid. In discussion, Mr. Duckworth described similar simian features in Australian brains, with frequency of 50 per cent.; Prof. Grünbaum brought physiological evidence to corroborate the anatomical data; Prof. Windle and Prof. Macalister fully accepted Dr. Elliot Smith's conclusions.

Mr. Duckworth showed photographs of the brain of a fœtal gorilla suggesting the artificial nature of the cerebral fissures. Prof. Grünbaum suggested histological examination, and Prof. Macalister summarised the history of the recent study of these features.

Mr. R. B. Seymour Sewell described some variations in the astragalus observed in 1000 specimens, mainly Egyptian. Their angle of collum and corpus is intermediate between the European and the anthropoid; changes in the articular surfaces are determined by the adoption of certain postures, and by the progressive eversion of the foot. Accessory facets are occasionally present, and facets are occasionally fused or absent. The os trigonum is very variable. Prof. Windle criticised Pfitzner's view of the os trigonum.

Mr. P. P. Laidlaw described some varieties of the os calcis, based on the Cambridge collections, namely:—(1) variability of the processus trochlearis, which seems not to develop from a separate ossicle; (2) external plantar tubercle; (3) calcaneus secundarius of Gruber; (4) os sustentaculi proprium; (5) processus trochlearis of Kyrtl, shown to be pathological; (6) variation of facets due to ossicles and other factors; (7) European reduced projection of the heel due to backward extension of the fascia articularis posterior. In discussion, he gave the length of the Egyptian heel-bone as 3 per cent. more than that of the European.

Mr. F. G. Parsons's paper on facial expression discussed the anatomy of the facial muscles, and illustrated their effects from historic portraits. Prof. Windle attributed alteration of expression to habitual action of certain muscles, probably recorded in the subcutaneous tissues; on this fœtal evidence should be decisive. Mr. Parsons replied that subcutaneous thickening is already perceptible at the ninth month.

Mr. J. Gray proposed a new system of classifying the records in anthropometric identification. The Bertillon system with fixed subdivisions only identifies 61 per cent. on the first search. The system proposed substitutes progressive subclassification of the data of one measurement by the data of the next in order. Search is further simplified by the use of charts on which dimensions used as coordinates determine the position of a record-number. The discussion only emphasised the need of accurate measurement.

The committee on anthropometric investigations among the native troops of the Egyptian Army reported progress in coordinating Dr. Myers's data. The modern population of Kena province shows less variability in head length and breadth than the prehistoric population (at Nagada), but more in cephalic index. The greater variability of Theban mummies is explicable by racial admixture in a large city. The objections raised to inferences from conscript data seem to be invalid. The Coptic population is apparently more variable than the Mohammedan, apparently because variability increases the chance of survival, and so multiplies among the oppressed.

Dr. Myers's paper on the variability of ancient and modern peoples elaborated the last-named point in comparison with data from elsewhere. Ancient and modern peoples do not seriously differ in variability, provided the external conditions are similar, while favourable conditions tend to homogeneity, *i.e.* regression towards the mean; and *vice versâ*.

Mr. Duckworth discussed the methods of graphical representation of the various racial human types employed by Keane, Flinders Petrie, Thomson, and Strentz, and proposed the simile of a protoplasmic origin modified into processes representing the various morphological types.

Prof. A. Macalister exhibited a series of Amorite crania from excavations at Gezer, in Palestine. The people of the first two strata practised cremation, and so destroyed their skulls, but the third and fourth strata show burials in contracted posture, accompanied by food vessels.

Linguistics.

On the morning of August 22 Sir Richard Temple, Bart., explained a plan for a uniform scientific record of the languages of savages, which starts from the sentence as unit-expression of a complete meaning, and classifies words according to their function in the sentence. The forms assumed by words grow out of these functions, and are determined by sundry functional affixes. The sentence considered as the elementary component of a language indicates the outlines of a classification of languages, and the conditions under which languages and linguistic groups develop. The plan has been successfully applied to several savage tongues, as well as to Latin, English, and Hungarian, and claims consideration as leading to rapid and accurate analysis and acquisition of language.

General Ethnology.

Mr. A. W. Howitt read on Monday a paper on group-marriage in Australian tribes. Among the tribes round Lake Eyre, two forms of marriage occur. One follows upon betrothal of children by their mothers, and the other is the subsequent marriage of the woman to a younger brother of her husband. On ceremonial occasions this latter form of marriage is extended in the tribe by the allotment to each other of men and women who are already allotted to each other under one or other of the two marriages. This group-marriage also occurs in other tribes in south-east Australia, either in the form which it has in the Lake Eyre tribes or as a survival of custom. It is shown by the system of relationship in the Australian tribes to have been at one time common to all. In the Lake Eyre tribes there is female descent with group-marriage. In other tribes in which group-marriage is merely a survival, or is merely indicated by the terminology of relationship, there has been more or less an approach to a form of individual marriage accompanied by a change from female to male descent. Changes such as these are attended also by alteration of the social organisation of the tribes. In one direction there has been a segmentation of the tribe from a division of two intermarrying exogamous moieties of the tribal community to four such divisions, and finally into eight, with a change also in the line of descent. In the other direction there has been a partial or complete loss of this division of the community into four and eight segments. The tribe has become organised on a geographical basis into a number of local groups, and these localities have become exogamous and intermarrying. In these changes in the organisation of the tribes the line of descent has passed from the female to the male line. In the Lake Eyre tribes a group of totems is attached to each exogamous moiety. These remain in existence in the segmentation into four and eight groups. In those tribes where the organisation of the tribe has become local, the totem groups have either become more or less extinct or have changed in extreme cases into magial names without influence in marriage.

Mr. R. S. Lepper offered a discussion of the passing of the matriarchate as observed in southern India, but devoted the time allotted to him to an exhibit of photographs of more or less matriarchal peoples.

On Wednesday M. E. Demolins submitted, under the title "Classification Sociale," an elaborate analysis of types of human society, based upon that of Le Play, but designed to supersede it by a system based upon modern ethnological data. All human societies are either communistic, relying for social progress on the community rather than on the individual, or particularist, with the reverse tendency. The former dominates the east, and explains its immobility; the latter the west, and causes its progress. The communistic societies pass through the three stages of stability, instability, and chaos. In the third, communism is seen breaking down, as in ancient Greece and Italy, or in eastern Europe now. The particularist societies are in turn rudimentary, chaotic (*ébranlée*), and advanced; to the last, as illustrated in Greater Britain and the United States, belong the social types of the future. Within these main types social growth is conditioned by geographical considerations, which determine the dominant forms of human industry and the institutions which result. The paper, which was well illustrated by printed diagrams, gave rise to a lively discussion.

Dr. W. H. R. Rivers described the funeral ceremonies of the Todas. Among points not previously noted are:—(1) the laying of a cloth on the body by those who have married into the clan; (2) a purification-rite, in which a man in woman's ornaments touches the remains with a bow and arrow; (3) the Toda beliefs as to the incidents of the journey to the other world.

Mr. E. S. Hartland exhibited a votive offering from Korea, representing a tiger in roughly cast iron. The Korean mountains are infested by tigers, which were formerly worshipped, and every pass has its votive shrine; probably, therefore, this votive tiger belongs to some tiger-cult.

Mr. E. P. Martin's paper on the Fulahs of Nigeria, and Prof. Ridgeway's anthropological view of the origin of tragedy, were taken as read.

Ægean Archaeology.

The morning session of August 23 was devoted to the results of recent exploration in Crete, and the section adjourned to the New Theatre to secure accommodation for the more numerous audience.

The proceedings opened with a brief address from Dr. P. Kabbadias, Inspector-General of Antiquities in Athens, who discussed the reasons for the great rarity of Neolithic remains in Greek lands, and described the recent operations of the Greek Archæological Society in Thessaly. Dr. Kabbadias's appearance was received with the utmost cordiality, and expression was given by Sir John Evans, Sir Richard Jebb, and by two successive directors of the British School of Archæology in Athens to the general appreciation of his services to the cause of Greek antiquities and to the foreign students of all nationalities in Athens.

The report of the Cretan Exploration Committee summarised the course of the British excavations of 1904, and left the way clear for discussion of the results.

Dr. Arthur Evans, F.R.S., explained his preliminary scheme for the classification and approximate chronology of the periods of Minoan culture in Crete, from the close of the Neolithic to the early Iron age. To the period as a whole it is proposed definitely to attach the name *Minoan*, as indicating the probable duration of successive dynasties of priest-kings, the tradition of which has taken abiding form in the name of Minos. It is proposed to divide this Minoan era into three main periods, early, middle, and late, each with a first, second, and third subperiod. The use of the word *Mycenaean* should be confined to objects of the late and subsidiary outgrowth (*Late Minoan III.*), when the fine motives of the "last Palace Period" at Knossos (now *Late Minoan II.*) are already in the state of decadence observable at Tell-el-Amarna (about 1400 B.C.), and even in earlier objects associated with cartouches of Amenhotep III. and his Queen, in Egypt, Rhodes, Mycenæ, and elsewhere. The less decadent forerunners of this style, in the new-found cemetery at Knossos, are still later than the art of the "last Palace Period." The third late Minoan period may thus be roughly dated between 1500 B.C. and 1100 B.C.

Late Minoan II., which precedes it, is best illustrated, in the latest palace at Knossos, by the fine "Palace style," with its strong architectonic elements, and marked correspondence, in its latest stage, with the art of the Kefts

and "Peoples of the Isles of the Sea" on Egyptian monuments of the sixteenth century B.C.; and the royal tomb at Knossos contains alabaster vessels of early eighteenth dynasty date. But the "Palace style" must itself represent a considerable period of development, and its earlier phases must go back at least a century earlier. *Late Minoan II.* may thus extend from about 1700 B.C. to 1500 B.C., corresponding with the Mycenæan shaft graves, and at Knossos with the later Class B of the Palace archives in linear script.

Late Minoan I., an earlier stage of the later Palace, marked off by an extensive catastrophe, is clearly shown in the "Temple Repositories" as an age of ceramic transition with naturalistic art at its highest perfection, and Class A of the linear script. The elaborate lid with King Khyan's name, and a monument of thirteenth dynasty period, date this stratum between 1900 B.C. and 1700 B.C.

The *Middle Minoan* age is especially characterised by the polychrome style of vase-painting on a dark ground, and by the conventionalised pictographic script which precedes the linear. In *Middle Minoan III.* the polychrome is degenerate, and naturalism, in reliefs and on gems, is growing; and it is in *Middle Minoan II.* that the polychrome (formerly "Kamares") style reaches its acme. The beginning of this stage is approximately dated by Egyptian motives on the seal-stones, and by the sherds found by Prof. Petrie in the rubbish-heaps of Kahun, dating from the time of Usertesen II. of the twelfth dynasty (2300 B.C. acc. to Lepsius; Petrie and others say nearly 2700 B.C.). In any case the Cretan evidence excludes the recent theory which makes the twelfth dynasty border on the eighteenth. *Middle Minoan I.* is also represented among the Kahun sherds (which thus give a precise upper limit for *Middle Minoan II.*), and mounts back at least to the middle, and perhaps (on Petrie's chronology) to the beginning of the third millennium.

Beyond this lies the long *Early Minoan* cycle of nascent culture, with geometrical decoration and ornament, generally dark on a light ground, though the dark glaze slip itself goes back to the confines of the Neolithic. Raised decoration on the surface of the clay is also abundant, and the hand-polished, dark-faced Neolithic ware survives throughout. The painted decoration also betrays the influence of the earlier incised designs. A section opened below the pavement of the west court shows a distinct stratification of floor levels of this period, of which the earliest (sub-Neolithic) shows incipient light-ground technique, improved Neolithic fabrics, and the first spiral ornaments, carved or incised, the prototypes, probably Cycladic in origin, of the later painted spirals. Early Minoan seal-stones show adaptation of seventh dynasty motives, and vases of syenite, &c., betray intercourse with dynasties I. to IV., while imported black ware from the first dynasty layer at Abydos is indistinguishable from that of sub-Neolithic Knossos. Comparison of Neolithic with Minoan rates of accumulation of débris gives a probable antiquity for Knossos of 12,000 years in all.

Discussion was opened by Prof. Ridgeway, who agreed with the proposed chronology as far back as the beginning of the eighteenth dynasty, but was not satisfied in regard to the twelfth and beyond. The name "Mycenæan" was no longer appropriate in a generic sense, but the term "Minoan" was open to a similar objection when applied to a period so long and early. His chronological objections were supported in detail by Mr. J. Garstang. Lord Avebury, on the other hand, expressed himself prepared for even longer periods in prehistoric chronology, and Prof. Sayce agreed that the interval between dynasties XII. and XVIII., though archæologically a blank in Egypt, may have been a long one. Dr. Kabbadias and Mr. Hogarth discussed the relations in which Minoan culture stands to Hellenic, the former laying stress on the sociological differences, the latter on the continuity in artistic essentials.

Dr. Evans, in reply, agreed as to the large element of survival from Minoan to Hellenic time, but laid stress on the evidence for the introduction of a fresh ethnic element in the interval. Mr. Garstang's criticisms did not affect the proof that the respective stages of Minoan and Egyptian culture synchronised at the points indicated in his classification.

Other papers on Cretan archæology followed.

Mr. R. M. Dawkins described the painted vases of the Bronze age from Palaikastro, in eastern Crete, with special reference to the styles of decoration, to which Dr. Evans's Knossian classification is applicable at all important points.

Mr. R. C. Bosanquet reported progress in the British School's excavations at Heleia (Palaikastro) and Praisos; a late Mycenæan palace has been excavated, and the main street further explored, with the adjacent houses; more middle Minoan ossuaries have been opened, and also a very early burial-place near Kastri, and a later cemetery with larnax-burials. A steatite libation-table yielded an inscription of seventeen Minoan characters. Within the Minoan town a shattered Hellenic sanctuary contained a slab inscribed in letters of Roman date with an archaic Doric hymn in honour of Young Zeus. This identifies the site with the temple of Zeus Diktaios, and consequently the plain of Palaikastro with the classical place Heleia. At Praisos the west face of the Altar Hill has yielded fragments of architecture and inscriptions from a sanctuary on the summit, among them a fresh document of the Eteocretan language in Hellenic characters of the third or fourth century B.C.

Sir Richard Jebb gave a rendering of the hymn to Zeus, and discussed its allusions to the Curetes and their cult, adding a suggestion (based on Plato, *Laws* 624 A) as to the "nine-year" legend of Minoan legislation; and Prof. R. S. Conway discussed the linguistic character of the Eteocretan language in the light of the new inscription from Praisos, which confirms previous results, and indicates an Indo-European type.

Mr. R. C. Bosanquet described a find of copper ingots at Chalcis, in Eubœa, nineteen in number, and of a characteristic Bronze age form already known from Crete, Cyprus, and Sardinia. The source of supply was probably in Othrys, while Chalcis was the chief emporium. The bronze axe-heads frequently found hoarded in the Ægean (*e.g.* recently in Othrys itself) have shaft-holes too small for use, and may be currency. The memory survived in the Cretan expression "axe" for a fraction of a talent.

Prof. Oscar Montelius gave a well illustrated description of the geometric period in Greece, which succeeds the Mycenæan (late Minoan) in Hellas and the Ægean, though apparently not in Asia Minor. He rejects the view that the geometric style is derived from countries north of Greece, holding that its characteristic motives appear earlier in Greece than in the north. He regards it as a modified continuation of the Mycenæan style, not due merely to the migration of the Dorians (as it is well marked in Attica, which they did not conquer), but mainly to the expulsion of the Tyrrhenian or Pelasgian foreigners, to whom he attributes the Mycenæan culture. He dates the geometric period between the twelfth and the close of the eighth century, and divides it into the three stages marked by the Dipylon, Phaleron, and pre-Corinthian types of vases.

Other Archaeological Papers.

Prof. Valdemar Schmidt, of Copenhagen, summarised the latest discoveries in prehistoric science in Denmark. The musical properties of the famous Bronze age trumpets in the Copenhagen Museum have been re-discovered, and are utilised annually. An earlier period has been established in the Danish Stone age than those of the "kitchen-middens" and the dolmens; for a peat bog in W. Zeeland, near Mullerey Harbour, yields implements of early types which were dropped by the inhabitants of floating "raft-dwellings." Examination of the impressions of corn grains in prehistoric pottery has established the kinds of wheat and barley which were cultivated at different periods. Systematic archæological survey has established the true distribution of tumuli and other monuments. The tumuli follow lines which avoid swamps, converge on fords, and otherwise betray themselves as roads, and offer valuable clues for the location of settlements along them.

Miss Nina Layard's further excavations on a Palæolithic site in Ipswich determined a Palæolithic floor sloping to the margin of a former lake, all now buried 8 feet to 12 feet

in brickearth. Forty implements and numerous chipped fragments have been found, and the position of certain well wrought oval implements, in and under compact clay at the lowest levels, identifies them as missiles hurled at water-fowl on the lake. Teeth of elephant, rhinoceros, ox, and deer occur in coarse gravel below the implement layer, and plant-roots in the clay below that.

Prof. E. B. Poulton exhibited records of Palæolithic man from a new locality on the north-east coast of the Isle of Wight, including every stage from flake to finished implement.

The sixth report of the committee on the lake village at Glastonbury announced fresh excavation in 1904, under the joint superintendence of Mr. A. Bulleid and Mr. H. St. G. Gray. Eight mounds, containing two or more floors, were examined, and plans and photographs secured. Objects of amber, glass, and tin, and an adze of iron were found, as well as bronze, stone, and bone objects, and pottery. In one mound, peas were found in some quantity. Arrangements are in progress for the publication of the results of the whole excavation.

Mr. F. R. Coles and Dr. T. H. Bryce described an interment of the early Iron age found at Moredun, near Edinburgh, in 1903. A cist covered with flagstones contained fragmentary human remains of normal local type, with a fibula of La Tène type, a ring-brooch, and a circular open pinhead, indicating a date not later than the second century A.D. This is the first completely attested interment of early Iron age in Scotland.

Dr. T. H. Bryce discussed a phase of transition between the chambered cairns and closed cists in the south-west corner of Scotland. The clue is given by a cairn at Glecknabae, in Bute, which contained two "atypical" chambers set radially in the cairn and containing burnt bones, and a closed cist with unburnt interment. One of the chambers also contained an unburnt fragment. The pottery, which included both typical "chamber" pottery and also fragments of the "beaker" class, indicated a triple occupation of the site, and a late date for the reduced atypical chamber.

The report of the Roman sites committee described work in progress at Silchester and Caerwent, and Mr. T. Ashby summarised the season's progress on the latter site. The south gate has been found to be parallel to the gate on the other side, and an inscription dedicated to Mars bears the date August 23, 152 A.D.

Prof. Flinders Petrie's excavations at Ehnasya have been already mentioned in connection with his series of Roman lamps. Ehnasya is the Roman Herakleopolis Magna and the Egyptian Henensuten, about 70 miles south of Cairo and 10 miles from the Nile. It was the home of the ninth and tenth dynasties, of which hardly anything is known. It is found to contain temples of the eighteenth and twelfth dynasties, and under the latter a stratum of older houses and burials with scarabs of Antef V. This king has recently been assigned to dynasty XVI. or XVII., but is thus brought earlier than dynasty XII. Later buildings of dynasty XXIII. yielded a fine votive statuette, in gold, of the local ram-headed deity, Hershefia, dedicated by a vassal of King Piankhi; and houses of Roman date gave important evidence as to the stages by which Christianity first displaced the native animal-cults, and then itself absorbed the Isis and Horus worship as the Madonna-cult.

Mr. J. Garstang described his excavations in the Royal tomb of Negadeh, in Upper Egypt, which completed the work begun some years back by the French, and recovered another fragment of the "Tablet of Mena," to whom the tomb has been commonly attributed.

Mr. R. N. Hall's recent excavations at Great Zimbabwe show the ruins to be three times larger than was supposed, and distinguish clearly between (*a*) the original constructions (*e.g.* the eastern half of the "Elliptical Temple"), which are still of uncertain age and associated with numerous phalli, and (*b*) sundry additions which are shown by Arab pottery to be not older than about 1300 A.D., and do not contain phallic objects. Much useful work has been done on behalf of the Chartered Company to preserve existing structures, and to clear the ruins of surface deposits and other obstacles to study.

BOTANY AT THE BRITISH ASSOCIATION.

THE meeting of the botanical section at Cambridge may probably be regarded as the most successful of the whole series of meetings which have been held since botany was constituted a separate section of the British Association. A large number of distinguished foreign botanists were present, and there was a fully representative gathering of British botanists to meet them. By the kindness of Prof. H. Marshall Ward, F.R.S., the meetings were held in the rooms of the new botany school, which proved to be admirably suited for the purpose. Prof. Ward and the botanical staff are to be congratulated upon the excellent arrangements made for the lectures, lantern demonstrations, exhibition of apparatus and specimens, &c., which contributed so much to make the meeting a success.

The president (Mr. Francis Darwin, F.R.S.) in his address, which has already appeared in NATURE (September 8), dealt with the perception of the force of gravity by plants, and especially with the statolith theory of geotropism.

The general work of the section included, in addition to the more technical papers, the usual semi-popular lecture, and a series of three addresses of a general character on important topics.

The subject of the semi-popular lecture, which was delivered by Dr. D. H. Scott, F.R.S., was a new aspect of the Carboniferous flora. It was shown that Brongniart's conception of the Carboniferous period as the reign of Cryptogams can no longer be maintained. Recent work has all tended to show that a large number—perhaps the majority—of the so-called ferns of that period were not true ferns at all, but seed-bearing plants approaching the Cycadophyta. While their affinity with ferns is evident, these plants had already acquired spermatophytic methods of reproduction—hence the name Pteridospermeæ is proposed for them. If we further take into account the seed-plants previously known—notably the Cordaiteæ—and those Lycopods which produced organs analogous to seeds, we are led to the conclusion that quite half the vascular plants of the Carboniferous period had already assumed the seed-habit.

Ecology.

Prof. A. G. Tansley, in an address on the problems of ecology, defined ecology for his purpose as the study of those relations of plants to their environment dependent on geographical and topographical factors. It is very largely topographical aggregates, due to soil, water, and other conditions with which ecology has to do, and the study of these falls into two parts, descriptive and experimental. The problems to be solved may be indicated during the progress of an ordinary botanical survey, but it requires the establishment of experimental stations in regions characterised by definite and specialised floras in order that the detailed investigation of the functional relations of plants to their surroundings may be more completely carried out.

Dr. W. G. Smith, whose work in connection with the botanical surveys of the north of England is so well known, in referring to the ecological aspect of the British flora, pointed out that a general survey of the chief plant associations of Britain has so far revealed some broad principles of distribution in relation to soil and climate, and that when wider areas are investigated the chief plant associations may be more clearly defined as climatic, edaphic, or biological formations.

Mr. T. W. Woodhead gave an interesting account of his observations on the biology and distribution of woodland plants, and dealt with some of the principal factors, such as shade, soil, &c., which tend to modify the plant associations under trees.

Prof. A. Engler (Berlin) read a paper on the plants of the northern temperate zone in their transition to the high mountains of tropical Africa, in which he pointed out that the differences seen in most of the highland forms of plants of tropical Africa, as compared with their relatives of the northern temperate zone, are always in harmony with the different climatic conditions. The modifications observed may be regarded as adaptations, but only in the sense that the adaptation is a passive one caused by the physical con-

ditions of the climate, not an active one corresponding to the views of the Lamarckians.

Mr. Francis J. Lewis presented a paper on the inter-Glacial and post-Glacial beds of the Cross Fell district, in which he pointed out that the plant remains are of considerable interest as throwing light upon the duration and climatic conditions of the several Glacial and inter-Glacial periods. The plant remains of the post-Glacial peat also show that considerable fluctuations have taken place in climate since the close of the Glacial period.

Morphology (including Palaeobotany).

Dr. D. H. Scott, F.R.S., described a new type of sphenophyllaceous cone from the Lower Coal-measures; the cone shows the anatomy and general organisation characteristic of the group, but is distinguished by its branched sporangiophores terminating in peltate, bisporangiate scales, and by the absence of any sterile appendages.

In conjunction with Mr. E. A. Newell Arber, Dr. Scott also presented a short account of two new Lagenostomas. In one of them, *L. Kidstoni*, the seeds are naked, but in the other, *L. Sinclari*, there are indications of an external envelope or cupule. The new seeds were apparently borne on the ultimate branches of a frond in which the lamina had been greatly reduced. There are indications that the fronds were of the Sphenopteris type.

Prof. C. Eg. Bertrand (Lille) contributed a paper by Prof. Cornaille and himself on "La structure de la trace foliaire des Filicinées inversicatenates."

Miss Sibille O. Ford gave an account of the anatomy of *Psilotum triquetrum*, from which she concludes that the Psilotaceæ not only present an affinity with the fossil Sphenophyllales, but also have a strong resemblance, anatomically, to some of the fossil Lycopods, especially to the stem of *Lepidodendron mundum*, as well as to the axis of the cone of *Lepidostrobus Brownii*.

Mr. T. G. Hill, in a paper on the presence of parichnos in recent plants, pointed out that in the mature sporophyll of *Isoctes Hystrix* in the lateral expansions of its base are two longitudinal mucilage-containing cavities which arise by the mucilaginous degeneration of two strands of parenchyma. He suggests that this represents the parichnos occurring in Lepidodendron, Sigillaria, Lepidocarpon, &c.

Dr. Marie G. Stopes described her recent observations on some new points observed in the ovular anatomy and structure in the different genera of Cycads, with the conclusion that there are well marked indications of two integuments.

Mr. L. A. Boodle read a paper on the reduction of the gametophyte in *Todea Fraseri*. Owing to delay in the dehiscence of the sporangium under certain conditions, many of the spores germinate within it. The prothallus may consist of only two or three cells with an antheridium. This is of special interest when compared with the microspores of Salvinia, as illustrating how a reduction of the thallus of a fern approaching that shown by Salvinia may be brought about by the non-dehiscence of the sporangium.

Dr. William H. Lang, in a paper on the reduction of the marchantiaceous type in Cyathodium, concludes that it appears probable that Cyathodium has been derived by adaptation to damp and ill lighted situations from a well characterised marchantiaceous form of about the same grade of differentiation as Targionia.

Dr. J. P. Lotsy (Leyden), in an interesting account of the virgin woods of Java, discussed the modifications produced in the vegetation by the two great forces moisture and light, and proposed the use of a new term, biaiomorphose, indicating that the form of each individual plant is not a form innate to that plant, but is the result of its specific structure and the sum of all external circumstances which have acted upon it.

Mr. E. A. Newell Arber presented a paper on a new feature in the morphology of the fern-like fossil Glossopteris.

Dr. Otto Stapf exhibited and described the fruits of Melocanna, Melocalamus, and Ochlandra.

Mrs. D. H. Scott gave demonstrations of kammatograph photographs showing the opening and closing of flower buds, the visits of insects to flowers, and other interesting records of the movements of plants.

Mr. Alfred P. Maudslay gave an account of some measurements he had made of the great swamp cypress at Santa Maria del Tule, Mexico. The area of a cross section of the trunk of this tree, at a height of 6 feet from the ground, is 408 square feet.

Dr. K. C. Miyake (Tokio) read a paper on the centrosome of the Hepaticæ, from which it appears that it is very doubtful whether centrosomes occur at all in these plants.

Lord Avebury, F.R.S., in a note on the forms of the stems of plants, brought forward the view that the shapes of the stems of plants are dependent upon the arrangements of the leaves, and the consequent distribution of the strengthening tissues in the stem so as to secure the greatest strength with the least expenditure of materials.

A short discussion on the present state of our knowledge of the cell structure of the Cyanophyceæ was opened by Mr. Harold Wager, F.R.S., who pointed out that the central body of the cell must be regarded as a nucleus, but that it is of a simpler or more rudimentary type than the nucleus of the higher plants.

Prof. E. Zacharias (Hamburg), whilst admitting that the central body contains, under certain conditions, that essential constituent of the nucleus, nuclein or chromatin, could not accept the view that it is a nucleus, and especially objected to Kohl's conclusion that it is a true nucleus in which both chromosome and spindle formation can be observed.

Prof. R. Chodat (Geneva) considered that the central body of the Cyanophyceæ is merely a specialised region of the cytoplasm in which granules of reserve substance accumulate, and not of the nature of a nucleus at all.

Mr. E. R. Burdon gave an account of the pineapple galls of the spruce which are caused by the hibernating generation of certain Aphidæ belonging to the genus Chermes.

In the early stages the chlorophyll, tannin, resin, resin canals, and secretory cells of every description disappear within the gall area, which consists entirely of enormously swollen parenchymatous cells. Starch is found in great abundance round the periphery of the gall area, and it is suggested that it may be the ultimate product of the disintegration of the tannin.

The nuclei of the galled cells also become enlarged, and the chromatin network becomes aggregated into numerous wart-like nucleoli. The mitotic figures are of the usual somatic type, and no indication of heterotypical mitoses has yet been found.

Mr. R. T. Baker exhibited specimens illustrating (1) the comparative constancy of specific characters of Eucalyptus, (2) the relation between the leaf venation and the oil constituents.

Prof. R. Chodat exhibited some beautiful examples of pure cultures of algæ, and Prof. G. S. West some photomicrographs of fresh-water plankton.

Physiology.

Dr. F. F. Blackman gave an interesting address on the important investigations which have been carried on by Miss Matthaei and himself on the question of sunshine and carbon-dioxide assimilation. The address was illustrated by a series of experiments, and the numerous elaborate and ingenious pieces of apparatus which have been devised by the authors for the automatic recording of the complicated data required were exhibited and explained.

Prof. S. H. Vines, F.R.S., gave an account of his researches on the proteases of plants, the general occurrence of which he has demonstrated in all parts of plants. They are not of the nature of pepsin, but correspond rather to either the trypsin or the erepsin of the animal body. Trypsin and erepsin differ from each other in their capacity for peptonising the higher proteids. Thus trypsin can peptonise so complex a proteid as fibrin, whereas erepsin cannot, though it can peptonise casein. It has been found that in certain cases the juices or extracts of plants can peptonise fibrin, indicating the presence of a tryptic protease; but more commonly they do not possess this capacity.

Prof. L. Errera (Brussels), in a paper on the localisation of alkaloids in plants, pointed out that, although the physiology of alkaloids is far from settled, a critical study of their topography, as well as their behaviour in germination, growth, etiolation, maturation of seeds, &c., supports the view that they are waste-products, resulting from the catabolism of cytoplasm, and secondarily utilised for defence against animals. A few grams of an alkaloid constitute a protection not less efficient than the strongest spines.

Prof. Errera also read a paper on the struggle for pre-eminence and inhibitory stimuli in plants, and Dr. J. P. Lotsy (Leyden) gave an account of his discovery of a new alkaloid in *Strychnos nux-vomica*.

Important papers were also read by Prof. R. Chodat (Geneva), on oxidising enzymes and katalases in plants; by Prof. G. Klebs (Halle), on the artificial formation of a new race; by Prof. F. Czapek (Prague), on the importance of the anti-ferment test in geotropically stimulated roots; by Prof. K. Fujii (Tokio), on the pollination of Gymnosperms; and by Dr. G. J. Peirce (California), on the dissemination and germination of *Arceuthobium occidentale*.

Mr. J. Parkin gave an experimental demonstration of a brilliant pigment appearing after injury in species of Jacobinia, the shoots of which when bruised and extracted with water yield a beautiful purplish liquid. Such a reducing agent as stannous chloride decolorises it. Micro-organisms can also readily bleach it when oxygen is excluded, but on allowing air to enter the original colour at once returns. The whole phenomenon bears some resemblance to the way in which indigo arises in plant-tissues.

Papers were also contributed by Dr. Otto V. Darbishire on the transpiration stream in small plants, and by Dr. George Barger on saponarine (soluble starch).

Fungi.

Prof. H. Marshall Ward, F.R.S., gave an address on recent researches in parasitic fungi. The investigations of De Bary and others were shortly described, and then Prof. Ward described his own experimental work on the determination of the external conditions necessary for the germination of the spores of fungi. He showed that a knowledge of the germinating capacity of the spores is necessary in order to arrive at definite conclusions as to the immunity of new varieties of cereals from disease. In opposition to Prof. Eriksson, he maintained that there is no evidence to show that fungus diseases are spread in any other way than by spores, and that his experimental and microscopic investigations do not in any way support Eriksson's mycoplasm theory.

Prof. Eriksson (Stockholm), in a paper on the vegetative life of some Uredineæ, dealt in considerable detail with this question, and sought to show that the evidence before us as to the infection of cereals by the disease could only be explained by the presence of mycoplasm in the seed.

Mr. V. H. Blackman and Miss Helen C. I. Fraser gave an account of the development of the æcidium of *Uromyces poae* and the life-history of *Puccinia malvacearum*, in which many new facts were brought forward, especially concerning the sexual fusion of nuclei in the æcidial cells.

Mr. E. S. Salmon described some further cultural experiments with biologic forms of the Erysiphaceæ which demonstrate the fact that the infection-powers of a "biologic form" are not altered by its residence for one generation on a strange host-plant, and give also some evidence in favour of the idea of the hereditary nature of the infection-powers of certain "biologic forms."

Mr. R. H. Biffen, in a paper on the inheritance of susceptibility to and immunity from the attacks of yellow rust, brought forward evidence to show that the liability to certain diseases is inherited, and from the results of crossing together races of wheat relatively immune from and highly susceptible to the attacks of *Puccinia glumarum*, it appears that susceptibility is dominant over immunity in the hybrid.

Miss C. M. Gibson gave an account of her infection experiments with various Uredineæ, which show that the germ tubes from the spores of any uredine may enter almost any plant, and that the attractive substance causing entry is not specialised in each species, but is something common to all plants.

Dr. A. H. Reginald Buller presented papers on the destruction of wooden paving blocks by the fungus *Lentinus lepideus*, Fr., and the reactions of the fruit-bodies of *Lentinus lepideus*, Fr., to external stimuli; and Mr. B. T. P. Barker on the structure of the ascocarp in the genus Monascus, and on some further observations on the ascocarp of Ryparobius.

Dr. A. F. Blakeslee (U.S.A.) briefly described his investigations on the sexuality of zygospore formation. According to their method of zygospore formation the Mucorineæ may be divided into homothallic and heterothallic forms. In the first group zygospores are developed from branches of the same thallus. In the second group, comprising probably a majority of the species, the zygospores are developed from branches which belong to thalli diverse in character. The sexual strains in an individual species show a more or less marked difference in vegetative luxuriance. The author concludes that the mycelium of the homothallic species is bisexual, whilst that of the heterothallic species is unisexual.

In the agricultural subsection, which met under the presidency of Prof. W. Somerville, the following papers were read:—improvement of wheats and Mendel's laws, R. H. Biffen; hybridisation of cereals, Dr. J. H. Wilson; the clover mystery: a probable solution of it, R. H. Elliott; analysis of soil by the plant, and the probable error of agricultural field experiments, A. D. Hall; determination of available phosphates, T. S. Dymond and G. Clark; sulphates in their relation to growth of crops, T. S. Dymond and F. Hughes; the improvement of clay pastures by leguminous plants, Prof. T. H. Middleton; formation of ammonia, nitrites, and nitrates, Dr. E. J. Russell; chemical composition of mangels, and variation in mangels, T. B. Wood and R. A. Berry. Prof. W. D. Atwater (Middletown, Conn., U.S.A.), who was present at the meeting, also communicated a paper to the section.

EDUCATION AT THE BRITISH ASSOCIATION.

AFTER the president's address (published in NATURE of September 15), the first paper on the programme was on the present educational position of logic and psychology, by Miss E. E. C. Jones, in which attention was directed to the fact that, on the one hand, logical and psychological studies hold a position of growing importance in English thought and education, while, on the other hand, the quality and organisation of the instruction supplied leave much to be desired. Some logic and psychology are now required for teachers' training examinations; it is also desirable that all students of religious doctrine or of the great questions of philosophy should be equipped with logical method and psychological knowledge.

The section listened with interest to the lucid account of the advances made in the teaching of experimental science in the secondary schools of Ireland given by the Right Rev. Gerald Molloy. The result of three years' work is splendid, thanks to a cordial and remarkable cooperation of teachers, of schools, and of local authorities with the Intermediate Education Board and the Department of Agriculture and Technical Instruction. These latter bodies have adopted a common programme in science subjects, and are carrying out a common system of examination and inspection. All the secondary schools of the country, about 250 in number, are enjoying the benefits due to judicious introduction of practical work in the laboratory, and the administrators may justly be congratulated on the fact that there are more than 9000 pupils following the preliminary course, and 1500 pursuing a more specialised course after passing through the preliminary. The manner in which the first great difficulty, that of providing competent teachers, was overcome is interesting, but it is of more importance now to note that the organisers took the right road to efficiency by putting men first and bricks and mortar second. (Might not some of our local authorities and governing bodies in England receive a useful hint?) For the future "the Department propose to grant the 'Irish Teacher's Science Certificate' to all students who pass through a three years' course, prescribed for the purpose, in the Royal College of Science, Dublin. They will also recognise as qualified teachers students who have followed a similar course in any university or technical college, and who have obtained the corresponding degree or diploma."

The discussion was mainly congratulatory, but one criticism deserves, and will no doubt receive, careful consideration from the authorities. It was felt by many that among subjects relegated to the optional courses were some of such fundamental importance as to be an indispensable part of an all-round education. This, of course, is part of the wide and difficult problem which is getting more and more pressing, viz. what can be safely *left out* of the secondary school curriculum? It is safe to reply to Dr.

Molloy's question, as to the advisability of limiting the preliminary science course to those who do not take the classical, by affirming that *all* boys and girls should take a science course of some kind at some period of their school life. Sir Philip Magnus insisted that science is not an "extra," but a necessary part of the curriculum (not for the whole time of all pupils). Inspection should precede examination—it is unnecessary to *examine* junior pupils. Mr. George Fletcher, speaking as an inspector, stated that other subjects of the curriculum have not suffered by the introduction of science into Irish schools. Their unparalleled progress was made possible by the voluntary sacrifice of their holidays by the teachers. Prof. Armstrong regretted that the courses of demonstrations, which had been instituted by the London School Board and had proved so valuable a help to science teachers, had been discontinued.

A paper which has attracted a widespread interest was that by Dr. J. de Körösy, director of municipal statistics at Budapest, entitled "Comparison of the Intellectual Power of the Two Sexes." The author had received reports since 1873 of 800,000 individual children. One method of testing applied was to take the percentage of children who had to repeat the year's work instead of passing on to the next standard. In the elementary schools the figures were all in favour of the girls, the two sexes being nearly level at first, but the advantage of the girls increasing with age. This result is more marked in the higher elementary or "citizen" schools (age ten to sixteen), but in this case the boys are drawn from a class less gifted than ordinary, while the opposite holds for girls.

Another test was the frequency of "very good" and "good" marks in the fourth standard. These best marks were obtained in arithmetic by 10·8 per cent. of boys and by 35·3 per cent. of girls. A truly surprising result! Several subsequent speakers admitted the superiority of girls at school and college, but contended that there it ended, but few women being eminent in learned professions, and the majority falling behind men when it came to the "struggle for existence." Dr. Beverley, of Norwich, differed from this view, arguing that women needed only equality of opportunity.

Mr. J. H. Leonard read a short paper on specialisation in science teaching in secondary schools. The contention was that the efficiency of science teaching in schools is itself threatened with a particular kind of specialism, *e.g.* objection was taken to the performance of titrations before sufficient progress has been made in elementary chemistry. The effect of according undue prominence to one study is that the school time is not fairly allotted—*e.g.* botany and physiography are often omitted—while the scholars are wearied instead of being interested. Unfortunately there was no time for discussion of Mr. Leonard's views.

Lieut.-Colonel McKinlay gave a description of his method of "realistic arithmetic." The "appeal to the eye" is thoroughly effective. The apparatus has been used in schools with favourable results.

School Certificates.

The main feature on the morning of August 19 was the discussion on school-leaving certificates. Prof. Armstrong led off by reading a "Report of the Committee on the Influence of Examinations." He explained that the question of examinations had entered upon a new phase by the issue, on July 12, by the Board of Education, Whitehall, of suggestions for a system of *school certificates* submitted by the consultative committee to the board. The committee was not in a position, therefore, to publish a report in the true sense of the word, but was presenting a compendium including the proposals of the consultative committee, notes on the Scotch leaving certificate, the London University scheme, and extracts from the Mosely Commission Report referring to the American accrediting system. Dr. Gray (Bradfield College) read a paper, communicated by Canon Bell, narrating the origin of the proposals of the consultative committee. Attention was directed to the vexatious multiplicity of examinations, no fewer than 64 in the United Kingdom and 140 in the Empire being accepted as qualifying for entrance into one or more professional courses.

Sir Arthur Rücker said the position was complicated by the fact that Oxford, Cambridge, and London Universities have already carried out something in the nature of school-leaving examinations. The consultative committee had left the financial question out altogether. There had been no opportunity for the universities to consider the scheme of the consultative committee, but he, personally, was in favour of its general principles. Mr. Ernest Gray, M.P., regretted that the antiquated procedure of the British Association had left those attending this section in the dark as to the subjects to be brought forward until the meeting actually commenced. He thought that the scheme would revolutionise secondary schools, by enlarging the staff and increasing the length of school-life. The difficulties connected with fees must be met from other sources. The proposal was really a dual certificate, a junior and a senior; this principle was accepted by learned societies. A most valuable feature was the active share which the teachers are to take in the examination of their school; he thought that English teachers should be prepared to take the responsibility of recommending pupils, as is done in France. Schools should direct examinations, not *vice versâ*. Local authorities will insist on some form of examination, and will probably wish to see local schools grouped round local universities.

The Rev. R. D. Swallow, on the other hand, regarded the idea of encouraging local authorities to hold to local universities as most detrimental. Secondary schools of the old-fashioned type would remain under the influence of the old universities, but a new type was springing up which the consultative committee had ignored, the higher elementary school with the words higher elementary painted out and secondary painted in. Dr. Mangold (Berlin) sympathised with systems of examination in which the teacher plays an essential part. Proved to be very satisfactory in Germany, the plan of taking into account the teacher's knowledge of the character and abilities of his pupils should act well in this country.

Principal Griffiths (Cardiff) referred to the experience of the Central Welsh Board. There was a tendency for a central board to become rigid, and he hoped that any such board would perform advisory and inspective rather than executive functions. We have to remove from local authorities their distrust of teachers. The curious worship of examination results by such authorities seemed to be a growing evil. Sir Oliver Lodge stated that Birmingham will put into action a scheme similar to that recommended by what was, on the whole, the admirable report of the consultative committee. Teachers should determine the relative order of pupils; the outside inspector should standardise and not pretend to read all the papers. He hoped universities would accept each other's certificates, and that no vested interests would stand in the way of reform.

Mr. Alderman Fordham (vice-chairman Cambs. County Council) thought that the alleged distrust of teachers did not, in reality, exist. It was recognised that the highest respect must be paid to teachers of every grade as the vital bases of every part of their work. He was in favour of the Swiss system of public examination for all children, and was dissatisfied with the existing mode of testing elementary schools. Miss Cooper wanted varieties of examination, equatable by their known equivalents. Mr. Oscar Browning thought that parents were insufficiently considered; a parent has a right to know whether his child has been taught to a reasonable standard. Mr. Mollison (Clare College) pointed out that America had a great advantage in freedom from examinations, and urged that the establishment of a fresh State board would be a disaster. Dr. Gray, as a member of the Mosely Commission, feared that the absence of a national desire for education made it necessary for us to have something more than the accrediting system. Dr. Roberts, Messrs. Flather, Fitzpatrick, and Cloudesley Brereton also spoke. The chairman, summing up, expressed his conviction that we had little need to fear State control, as we have inherited so long a struggle for freedom that we are hardly likely to be tyrannised over. The consultative committee had looked the finance difficulty in the face—*and passed on.*

National and Local Provision for the Training of Teachers.

The discussion on this urgent problem opened on Monday, August 22, with a paper contributed by the Right Hon. Henry Hobhouse, M.P., the object of which was "to

indicate the difficulties which beset local bodies in their endeavours to perform what is really a national task."

By the recent regulations training is insisted upon as a condition for registration, but the actual establishment of training colleges has been left, *more suo*, to private initiative. Under the Act of 1902, the burden of supplying the deficiency is thrown, not upon the State, but upon local authorities. In addition to the difficulty which the smaller bodies would experience in raising funds for new institutions with expensive buildings and equipment, there is the further one of getting proper cooperation between so many authorities, autonomous and often jealous of each other. The most serious drawback of all lies in the "localisation" of the individual teacher. Certain local authorities may prefer to secure teachers trained elsewhere by the offer of high salaries rather than train them themselves. As a counter-move, a local authority may bind each teacher it trains to serve for a reasonable number of years exclusively in its own schools, a system of indenture which, however sound financially, is educationally unsound, and which will seriously prejudice free circulation of educational energy, with special detriment to the weaker counties and boroughs. The present problem is how to encourage and impel our local authorities each to bear its fair share in the task of increasing the supply of competent teachers without forcing them all into one groove, and depriving them of all initiative and independence.

Mr. H. Macan sent a paper which arrived too late for an abstract to be made thereof, and was too lengthy to read in full. In the circumstances justice could not be done to this contribution. *Inter alia* he pointed out that a central hall costing 30*l.* per place was worthless compared with good teachers. As a large number of teachers at present leave the profession at an early age, he suggested that there should be two classes of teachers, one highly trained, the others less qualified short-service persons sufficiently equipped for the journeyman-work of teaching. (The writer of these notes does not know what "journeyman-work" means as applied to teaching.)

Mr. Gray, M.P., said it was impossible to escape from the conclusion that the training of teachers should be a national charge. Secondary-school teachers needed better training in the art and craft of their profession, and the barrier between elementary and secondary should be removed. Mr. G. F. Daniell considered that the supply of men for secondary schools would be met if the kind of training required was made known, and proper pay, position, and conditions of work and tenure provided.

The Rev. W. T. A. Barber said that elementary teachers should have some practice in secondary schools during their training. The training college should be in connection with some university. To add a year's training in pedagogics to the costly years spent in graduating at a university would stop the supply of teachers for secondary schools unless the chances of the profession were improved. Dr. Ernest Cook, chairman of the Bristol Education Committee, complained that the ordinary training college provided secondary education, but very little instruction in the art of teaching.

Principal Griffiths referred to the position in Wales, where there is to be a congress of representatives of education committees, of the university, of teachers' associations, and of politicians to consider the position in the Principality. At present they needed to import 280 teachers from the neighbouring kingdom of England. He feared the effect of enlarging day training colleges, and wished to remove distinctions between "normal" and ordinary university students. Sir John Gorst said the difficulty of supplying teachers had increased since the 1902 Act was passed, and pressed for energetic measures to be taken both by Government and the local authorities. "Supply and demand" would not suffice except for the great public schools. The pupil-teacher system was rather a failure, and the training college system not a success. The burden laid on the young pupil teacher was greater than anyone could bear. The qualifications of teachers should be certified by the university, which should supply pedagogics, no new expensive buildings being required, and the attempt to distinguish between elementary, secondary, and technical education should be abandoned. Assistance for training should be given from both Government and local funds. He thought the value of Ireland as a recruiting ground should receive attention.

Mr. J. L. Holland pointed out that we needed to know the actual number of teachers required, and stated the average life as a teacher to be, for a man, a little under 14·3 years, for a woman about 7 years. This means a fresh teacher per annum for every 2000 to 2500 of the population, and it should be noted that for every boy there are five girls going to be teachers. (The number of pupils in secondary schools in 1900 was:—boys a fraction over, girls a fraction under, five per thousand of the population.) The scholarship ladder is in danger of becoming a treadmill, leading from the school as a pupil to the same school as a teacher, through the bad influence of "localisation." Miss Walter said that the short professional life of teachers was due to low pay, and urged that more money be spent on salaries, in which case less would need to be spent on training.

M. Émile Havelaque, Inspector-General of Public Instruction in France, made a particularly interesting speech, in the course of which he dwelt on the advantage that would accrue if a larger number of English students for the higher branches of the profession could be induced to take up residence at French schools and colleges, under a newly instituted scheme. The student would be able to study French educational methods; the teaching of the mother tongue, for instance, has received particular attention in France, while it is surprisingly neglected in England.

Dr. Mangold observed that in Germany the training of teachers was a national charge, the masters of method receiving a small addition to their salaries as teachers. He was astonished that it should be desired to remove the differentiation between elementary and secondary—such removal would be impossible in Germany at present.

Manual Training.

Sir Philip Magnus opened the discussion on methods of imparting manual instruction in its broadest sense in the various types of schools. Other speakers included Mr. George Fletcher, Mr. Millett, Mr. Oscar Browning, Mrs. Marvin, Prof. Armstrong, Miss Cooper, and Miss Taylor. There was agreement as to the value of manual training as a part of general education for all boys and girls, and it was also felt by the opener and others that the instruction should have the same aim for the two sexes. On the other hand, the subjects used for this purpose should be different, the manual teaching of girls being associated closely with the domestic arts.

Reports of Committees.

Mr. Hugh Richardson presented an interim report of the committee on the courses of practical, experimental, and observational studies most suitable for elementary schools. Useful work is being done, and it is satisfactory to note that a grant has been made for its continuance.

The report of the committee on the conditions of health essential to the carrying on of the work of instruction in schools emphasised the need of teachers themselves being trained to understand how the laws of health entered into every department of school life. Suggestions were made for the curriculum for such training. The report was followed by a discussion on hungry and exhausted children, led by Sir John Gorst, who boldly advocated that local authorities should be empowered to feed half-starved children and to punish those responsible for their neglect.

Afternoon Lectures.

On August 19 Mr. A. D. Hall lectured on the need of scientific method in elementary rural instruction, and on August 22 Prof. Armstrong gave a short address on the research method applied to experimental teaching.

The founders of the section should be well satisfied with the position which it has taken in so short a time. The gathering at Cambridge was remarkable for the bringing together of workers in every branch of the diverse paths of education. The debates were thoroughly well sustained, and with better arrangements for continuing the work of committees between the annual meetings, and some improvement of machinery for advertising the subjects to be discussed beforehand, there can be no doubt that Section L will exercise a useful national influence. G. F. D.

THE OPENING OF THE MEDICAL SESSION.

THE beginning of October always sees the opening of the medical session, and introductory addresses have been delivered at many of the London and provincial schools. At others, however, the session opened without formality.

At University College Prof. Norman Collie, F.R.S., delivered the introductory address, taking for his subject the relation of chemistry to medicine. He said that it is now more than ever imperative that medical men should have a good grounding in chemistry, and he directed attention to the numerous instances in which chemistry has a bearing on medicine. The question of the action of ferments, of great importance to the medical man, must ultimately be answered by the chemist. The physiological action of toxines and antitoxines has for some time largely engaged the attention of medical science, but it will probably be the chemist, after he has determined their molecular structure, who will be able to explain how and why they are produced. In the process of the assimilation of food the changes that occur are purely chemical. The composition of the various secretions also can only be arrived at by an analysis in a chemical laboratory.

At King's College the session was opened with an address by Dr. Thomas Buzzard, F.R.S., on the future relation of King's College to its medical school and hospital. After a few words of welcome to new students, and impressing on his audience the value of the degrees of the University of London, he briefly sketched what will be the position of college and hospital when the latter has been removed to Camberwell. It is intended that the two should be distinct, the preliminary and intermediate studies being pursued at the college, the subsequent more purely medical studies at the hospital. At the same time the two will be autonomous, and there will be no obligation on a student who completes his preliminary studies at the college to pass on to King's College Hospital; he will be at liberty to go where he pleases. In order to carry out this separation, composition fees will be abolished, and no member of the hospital staff will be permitted to teach any preliminary or intermediate subject at the college.

Dr. A. E. Wright, in the opening address at St. Mary's Hospital, emphasised the importance of research and the need for the provision of adequate salaries for scientific workers.

Dr. F. J. Wethered, in his address on practice and theory in medical study at the Middlesex Hospital, also spoke of the need for the endowment of chairs in the University of London. He pointed out that medicine is not only a science, it is a practical art, and no amount of theoretical knowledge can replace study and observation in the wards and out-patient room.

At Charing Cross Hospital the opportunity of the opening of the session was taken for the delivery of the Huxley lecture. The lecturer this year was Sir William MacEwen, who prefaced his remarks with some allusion to the life-work of Huxley before passing on to his subject, "The Recent Advances in Science and their Bearing on Medicine and Surgery."

Prof. Alex. Macalister, F.R.S., was the lecturer at St. George's Hospital, and delivered an instructive address on "The Evolution of the Medical Curriculum."

At the London (Royal Free Hospital) School of Medicine for Women, and at the Royal Veterinary College, the sessions were opened by Miss Murdoch and by Prof. Brodie, F.R.S., respectively.

THE EDUCATION OF A CHEMIST.[1]

THE education of a chemist (and the word "chemist," of course, includes the qualification "technical chemist") must be conceived in the sense that it consists in an effort to produce an attitude of mind, rather than to instil definite knowledge. Of course the latter must not be neglected; the definite knowledge may be likened to the bricks which the architect has at his disposal in erecting a beautiful building; he knows their shapes, their capacity for resisting stresses, and, in short, what can be done with them. But the conception of the design is the result of many attempts to create; just as the poet has to utilise words, or the architect bricks, so the chemist has to know the materials with which he is dealing. The training of a bricklayer, however, will never make a man an architect; nor will the dry research of a grammarian train a poet. In short, it is the inventive faculty which must be cultivated.

Now how can this be brought about? The answer is perfectly simple: by offering examples. Every teacher in the laboratory, from senior professor to junior assistant, must be engaged in research, and, most important of all, they must not be reticent, but willing to converse freely on their problems. It is that which creates a "chemical atmosphere."

The qualities tested by such examinations as have been customary for the past forty years in England are the last which one would wish to have in a student of science—readiness of memory, to the exclusion of deliberate judgment; the faculty of spreading knowledge thin, and making a veneer of scientific facts instead of the power to correlate them and increase their value; and the skill to gauge the capacity of and hoodwink the examiner, instead of the power to incite enthusiasm in others. They are ideal qualities for a successful barrister, because they pay in his profession; but their reward has been the bane of science. A sound judgment, though it may be a slow one; persistence in struggling against obstacles; the knowledge where to get information when required, and to use it when found; and the inventive faculty—these are the qualities required, and they can be gauged only after long-continued observation. Moreover, the pernicious system of competitive scholarships and fellowships, instead of eleemosynary support given to the necessitous and deserving youth, has also contributed much to the debasement of the scientific spirit; for it has early implanted in the young mind the idea that to outrun his fellows, and to work solely for a money reward, are the ends to be aimed at, instead of the joy of the exercise of a divine gift, and the using that gift for the benefit of man.

The ideal plan of education for technical chemists would be some system analogous to the apprenticeship of engineers, after they have been educated in the science; that is, after the correct habit of mind has been largely formed. But it is difficult to see how this can be brought about. The obstacles in the way appear to me to be insurmountable. The chemical manufacturer is not willing to throw open his works to students, nor would he do so even if very considerable premiums were paid. Indeed, in England, it is not uncommon for the "chemist," so-called, to be refused admission to the works, and to be confined to the laboratory. In the larger German works, where many chemists are employed, it is possible for a young man to gain the requisite experience. I have been informed by the managing director of a chemical works in Germany where seventy chemists are employed that nature has divided the young men into three large classes, the members of which are fairly easily distinguished and do not greatly overlap. There is first the routine chemist, the young man who declines responsibility, but who is hardworking and trustworthy; he finds his place as an analyst, testing raw materials and analysing the products at various stages, including the finished products. Second, there is the young man to whom the management of some department may be entrusted; one with a firm will, plenty of energy, and the quality of governing men. And third, there is the research chemist, who delights in new problems, whether suggested by others or conceived by himself. All three classes are utilised; and after serving as analysts for some time, the young men naturally range themselves in one or other department, where their natural tendencies find scope. But even in Germany the number of works which employ seventy chemists is not great, and with a small number it is more difficult to effect the division of labour so satisfactorily.

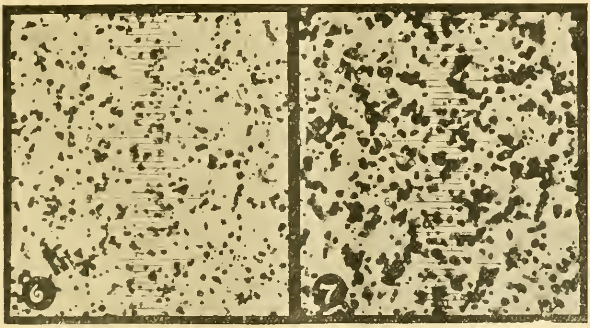
In conclusion, let me make one more remark. It is that the scientific curiosity of to-day often becomes the trade necessity of to-morrow. A scientific friend of mine once directed my attention to the fact that most of the changes which have been introduced in industry have had their origin in the universities. Why? Because the investigator is un-

[1] From an address delivered before the Society of Chemical Industry, at New York, September 8, by the president, Sir William Ramsay, K.C.B., F.R.S.

fettered. If a man sets himself to improve an existing process, he very likely may succeed, but he will not effect a revolution in manufacture. The purely scientific investigator who is free to follow indications of no apparent commercial import has not infrequently made discoveries of a radical nature, which have entirely changed some particular industry. I do not recommend the one to the exclusion of the other; both are best; and both are best attained by an intimate association between the universities and the chemical works. The investigator often learns much by the study of industrial processes. The chemical manufacturer who is keenly alive to his own interests will not fail to keep himself in touch with every discovery, however little it appears to be connected with his own industry.

THE GRAIN IN PHOTOGRAPHIC FILMS.

IN the September number of the *Astrophysical Journal* Mr. R. J. Wallace gives an account of his investigation of the circumstances that control the size of the silver particles in a developed gelatino-bromide plate. Of four rapid plates of American make, the "Seed 27, Gilt Edge" was found to give the best results. It was the most uniform in speed from time to time, and gave the least amount of "chemical fog," the smallest particles of silver, and the most regular distribution of them. While the particles were found to be, generally speaking, spherical in ordinary plates, isochromatic plates of several makes showed the peculiarity of having almost exclusively elongated (the author calls them "spicular") grains at the surface of the film, while in passing downwards through the film they gradually gave place to rounded particles, until close to the supporting glass these latter were the only ones found. Intensification increases the size of the particles; this is the common experience of those interested in these matters,



Before Intensification (1·3 to 4·0μ). After Intensification (2·8 to 10·4μ).

FIG. 1.—Photomicrographs of Silver "Grain."

but the author's demonstration is of special interest, as he performed the intensification with a brush, using the mercury and ammonia method, without shifting the plate, so that he was able to photograph the identical particles before and after the operation. The same grains can easily be traced in the two photographs reproduced. The magnification is 430 diameters. The author also shows the difference between rapid and slow development. In the first case he considers that the silver particles most nearly approach the size of the original particles of silver salt from which they are produced, while by prolonged development they become enlarged by reason of the formation of "group-particles" as well as by accretion. For the finest grain the author deprecates slow development. In a postscript reference is made to the deduction of Messrs. Lumière and Seyewetz from their recent experiments to the effect that neither the temperature, concentration, nor duration of development practically affects the size of the grain. The author considers that these investigators have neglected the formation of "group-particles" because they dissolved off the film after development and examined a new film made from the product.

THE DUCHESS OF SUTHERLAND'S SCHOOL AT GOLSPIE.

AS announced in our columns last year (September 24, 1903), the formal foundation of the Duchess of Sutherland's Technical School at Golspie was inaugurated on September 8, 1903, by Lord Balfour of Burleigh, at that time Secretary for Scotland. The building is, we are informed, now completed, the total cost of erection and equipment having exceeded 16,000*l*., exclusive of the site and grounds given by the Duke of Sutherland. The school is a handsome structure in white freestone, and three storeys in height. It contains altogether fifty-six rooms, including fourteen class-rooms, workshops, laboratories, museum, &c. The dormitories are 50 feet by 21 feet, with bathrooms and lavatories attached. The school when full can receive sixty pupils. The curriculum covers a period of three years, and the subjects comprised are such as are most likely to meet local industrial requirements, the whole course being framed on a sound scientific basis. In drafting the original scheme the duchess had the cooperation of Prof. R. Meldola, Prof. Magnus Maclean, Lord Balfour of Burleigh, the Right Hon. R. B. Haldane, and Mr. Struthers, of the Scotch Education Department. A formal deed has been executed by the duchess ensuring the perpetuity of the school, and appointing for its management a local board of governors, the duchess herself being chairman and the duke a member of this board. An advisory committee has also been appointed consisting of leading educationists and representatives of Highland societies, as well as Her Grace's original advisers.

The building and equipment fund has been raised entirely by private voluntary subscriptions, the Duke of Sutherland having contributed 8000*l*. Other munificent supporters of the scheme are Mr. Andrew Carnegie and Lord Strathcona, the Dukes of Portland and Westminster, Mr. James Coats, of Paisley, and Mrs. Carnegie. The cordial support which this new educational departure has received in Scotland will be recognised when it is stated that out of the sixty places in the school forty are provided for by bursaries guaranteed by various benefactors interested in the counties of Sutherland, Caithness, Ross and Cromarty, and one (by Mr. Dewar) for a student from Inverness-shire. Another indication of the local practical interest in the scheme is that at the opening of the school for regular work on October 3 the claims of more than sixty applicants for admission had been considered by the board of governors. Out of these, twenty-five bursars have been admitted as the first batch, and further admissions of bursars will be sanctioned for next year and for 1906.

It is proposed to work the school as a higher grade school under the Scotch Board of Education, and, in addition to the scientific and technical subjects, the ordinary literary and humanitarian subjects will be carried on from the elementary school stage, the standard of qualification required for admission as a bursar being that he should have completed his thirteenth year and have received the "merit certificate" or its equivalent. It is of interest to learn that the elementary schools from which the technical school will be supplied with pupils are cooperating most sympathetically in carrying out the scheme. One of the difficulties, as we learn from Prof. Meldola, which has beset the school in Essex founded by Lady Warwick, sister of the Duchess of Sutherland, has hitherto been the want of cooperation on the part of the local elementary schoolmasters.

The head-master of the new school is Mr. E. W. Read, of Cambridge, formerly agricultural instructor at the North-eastern County School, Barnard Castle, Durham.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The degree of Doctor of Science has been conferred upon Sir William Ramsay by Columbia University.

Dr. F. Cavers, lecturer in biology and botany at the Plymouth Technical Schools, has been appointed to the vacant professorship in biology at the Hartley University College, Southampton.

It is reported in *Science* that Prof. E. Wichert, of Göttingen, has been appointed to a chair of physics at Königsberg; Prof. Eduard Brückner, of Bern, has been elected professor of geography at Halle.

Prof. Hugh L. Callendar, F.R.S., will deliver an address to-day at the Victoria and Albert Museum on the occasion of the distribution of prizes, medals, &c., to students of the Royal College of Science.

We learn from *Science* that by the will of the late Dr. Henry Tuck, Harvard University will receive one fourth of the estate should his children not survive. The estate is valued at 1,000,000*l.* The effort to raise necessary funds towards the 30,000*l.* required for the new Eastman building of Rochester University, to be used for biology and physics, has been successful. Of the desired amount, the sum of 24,000*l.* is in hand, including 3000*l.* contributed by Mr. Hiram W. Sibley. Mr. Eastman, of Rochester, has given 12,000*l.* to the fund.

For the purpose of furthering the cause of education in the Transvaal, Mr. Alfred Beit has presented to the Government the Frankenwald estate, situated 12½ miles north-east of Johannesburg. The area of the estate is 1000 acres. The Government has purchased an adjoining piece of ground of 1000 acres, and Mr. Beit has spent an additional sum of 10,000*l.* himself on acquiring more ground. The total area available will thus be 2600 acres, a large portion of which is planted as orchards, vineyards, and nurseries, and part with timber trees, making the site admirably adapted for an agricultural college.

The Board of Education has issued the following list of successful candidates for royal exhibitions, national scholarships, and free studentships (science):—*Royal Exhibitions:* Albert Eagle, Henley-on-Thames; Sidney H. E. May, Portsmouth; William B. Wood, Sheerness-on-Sea; Edmund W. Spalding, Cambridge; Joseph Lloyd, Pembroke Dock; Albert E. Monkcom, Portsmouth; John S. G. Thomas, Morriston, Swansea. *National Scholarships for Mechanics:* Sidney R. Dight, Plymouth; Harold H. Perring, Devonport; Stewart S. Spears, Sheerness-on-Sea; Edwin M. Vigers, Plymouth; Thomas A. Colvill, Chatham. *Free Studentships for Mechanics:* Arthur G. London, Southsea; Bert H. Penn, London. *National Scholarships for Physics:* John F. Mitchell, Cathcart, N.B.; Tom Harris, London; Harry Moore, Bradford; Hubert Watson, Darwen; Frank P. Fuller, London. *Free Studentships for Physics:* David C. Jones, Bala, N. Wales; Lucy Alcock, London. *National Scholarships for Chemistry:* John Keegan, Burnley; Harold Talbot, Farnley, Leeds; Charles Salter, Leeds; Alexander M. Hird, South Woodford, Essex; Herbert W. King, South Tottenham; Frank D. Miles, Carlisle. *Free Studentships for Chemistry:* Harold Mountain, London; Alan C. Webber, Brighton. *National Scholarships for Biology:* Frederick J. F. Shaw, London; Frederick J. Bridgman, London; Arthur B. Lister, Burnley. *National Scholarships for Geology:* Thomas Reed, Burnley; Herbert G. Smith, Burnley; Henry J. Jeffery, London.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 26.—M. Mascart in the chair.—On a cause of variability of the errors of division in certain graduated circles: G. **Bigourdan.** It is usual to cut the actual graduations on a circle of silver let in to a support of another metal, such as brass or cast iron. The errors of graduation in astronomical instruments are usually determined once and assumed to remain constant, but it is now shown that owing to the differences between the coefficients of expansion of the metal and its support considerable errors may arise. Cast iron should not be used as the supporting metal, brass or bronze being preferable, but it would be better to drop the use of silver, which tarnishes rapidly in towns, and make the whole circle of one metal, a nickel-steel for preference.—The Perseids in 1904: Lucien **Libert.** Observations were carried out at Havre from August 11 to 20 under good conditions; 339 meteors were counted, and 93 trajectories determined.—On the energy dissipated in iron by hysteresis at high frequencies: Ch. Eug. **Guye** and A. **Schidlof.** It has been shown in a preceding note that the loss of energy in iron due to hysteresis may be represented as a quadratic function of the frequency, provided that the wires are of small diameter. It has now been found that if the wires are made still thinner, 0·0038 cm., the equation becomes sensibly linear. In other words, the energy consumed per cycle, for the limits of frequency used in the experiments, is independent of the speed with which the magnetisation cycle is carried out.—The constitution and properties of the tungsten steels: Léon **Guillet.** Tungsten steels fall into two groups—perlitic steels, which possess analogous properties with those of carbon steels, but which take a greater breaking load the higher the proportion of tungsten, and double carbide steels, the properties of which are nearly independent of the percentage of tungsten, and the fragility of which is independent of the amount of carbon.—Carbinol salts and cyclohexanerosanilines: phenomena of decoloration: Jules **Schmidlin.**

CONTENTS.

THURSDAY, OCTOBER 13, 1904.

ŒCOLOGICAL PLANT-GEOGRAPHY.

Plant-Geography upon a Physiological Basis. By Dr. A. F. W. Schimper. Translated by W. R. Fisher, B.A. Revised and edited by Percy Groom, M.A., D.Sc., F.L.S., and I. Bayley Balfour, M.A., M.D., F.R.S. Pp. xxx+839. (Oxford: University Press, 1903.) Price 42*s.* net.

WE welcome most heartily the appearance of this translation of Schimper's great work, "Pflanzen-Geographie auf physiologischer Grundlage," and the more so as it stands alone in being the only comprehensive work on œcological plant-geography in the English language.

The beginnings and gradual development of the study of œcology may be traced during the course of the last century in the writings of Humboldt, the De Candolles, Darwin, Grisebach, Drude, Kerner, Engler, and others. A new phase was marked by the appearance in 1896 of Warming's "Lehrbuch der ökologischen Pflanzen-Geographie" (the original Danish edition was published in 1895), and in 1898 of the larger work of Schimper. The latter, which forms the subject of this notice, possesses a wealth of well chosen illustrations absent from the text-book of Warming. But even these later works are, in spite of the undoubted advance which they mark, to be regarded largely as pioneers, for, to quote from the author's preface to the book before us:—

"A satisfactory general survey of œcological plant-distribution cannot be attempted with the material at present available. This book is therefore chiefly of a tentative nature, and attempts by a precise statement of pending questions to stimulate further research."

The work is divided into three parts. In the first (pp. 1–156) the various factors affecting plant-life are considered. The second (pp. 159–206) discusses the arrangement of vegetation into "formations" and "guilds"; while the third and largest part (pp. 209–839) is less general, and is largely occupied with a description of the vegetation of the zones and regions, thermal and other, into which the surface of the earth may be divided.

At the outset the author emphasises the fact that "the characteristics of organisms are physiological," and this application of the principles of physiology to the problems of morphology and distribution forms the idea underlying the whole of the book.

In addition to the generally accepted classes of "hygrophytes" and "xerophytes," Schimper recognises a third or intermediate type, which he calls "tropophytes." Under the latter term are included "all plants whose conditions of life are, according to the seasons of the year, alternately those of hygrophytes and xerophytes." Good examples of this class are our deciduous trees; these possess hygrophilous leaves, which are shed periodically, while the axes and buds, which alone are called upon to endure the "physiologically dry" conditions of winter, are distinctly xerophilous in character. Warming's class of "mesophytes," or plants adapted to medium conditions as regards moisture, was a convenient one, but the term "tropophytes" is to be preferred, as it directs attention to the physiological significance of many adaptations correlated with an alternation of wet and either dry or cold seasons.

Just as humidity is the dominant factor in determining the form of plants, so temperature plays the most important part in their distribution. The œcological importance of light, in spite of its powerful influence on the form and life of plants, is, according to the author, less than that of heat and rainfall, because the amount of light in different climatic regions is less variable than is the supply of the other two factors.

The remaining chapters of part i. are devoted to a discussion of the air, the soil, and animals as œcological factors.

In part ii., under the heading of "Formations and Guilds," the conditions which determine the differentiation of the earth's vegetation are dealt with. According to Schimper there are three controlling factors—the type of "vegetation" in the tropical and temperate zones is determined by the climatic humidity; the type of the "flora," especially as regards the larger systematic groups, is, so far at least as existing factors are concerned, dependent primarily on heat; while "the soil as a rule merely picks out and blends the material supplied by these two climatic factors, and on its own account adds a few details."

Two œcological groups of "formations" are distinguished:—(1) "climatic or district formations, the character of whose vegetation is governed by atmospheric precipitations"—these include three main types, woodland, grassland, and deserts—and (2) "edaphic or local formations, whose vegetation is chiefly determined by the nature of the soil"; such edaphic formations are moors, swamps, sand-dunes, &c. This grouping is an excellent one, but some will regret the use by the author of the term "formations"; admittedly it is difficult of definition, but as used here the term is unnecessarily wide, and includes groups of very unequal value. Another objection to its use is the fact that it has been employed by different authors in a variety of senses. Perhaps it would have been better to have followed the usage of Warming in the work cited above, and applied the term "vegetation" to the larger groups such as woodland, grassland, &c.; while for the smaller local ones, which are characterised by the presence of one or more dominant species, "plant-associations" ("Pflanzenvereine") could perhaps have hardly been improved upon.

Part iii. contains a masterly description of the vegetation of the globe from the œcological point of view. The primary division is into "zones," dependent on temperature, *i.e.* tropical, temperate, and arctic, and these occupy respectively the first three of the five sections which make up this part of the work. Each section begins with a general discussion of the characters of the climate of the particular zone under consideration, and stress is laid on the fact that periodic phenomena, or alternations of rest and activity in the functions of plants, occur as generally, though less obviously, in tropical as in temperate climates. Some

200 pages, or nearly a quarter of the whole work, are occupied by an excellent account of the tropical zones. Much of the recent advance in our knowledge of these regions is due to the establishment in the tropics of such botanical laboratories as those of Buitenzorg and Peradeniya: a research laboratory has also been recently established in the temperate desert regions of Arizona, and it is much to be hoped that the author's wish for the foundation of a similar institution in the arctic zone may ere long be realised.

The concluding sections of the book are devoted to a discussion of mountain and aquatic vegetation.

To sum up, the work is a thoroughly scientific exposition of our present knowledge of the factors which control the distribution of plants, and though the book in no sense expresses finality, yet, to quote from the editors' preface to the English edition, "its 'precise statement of pending questions' should not only 'stimulate research,' as the author hoped, but should also have a steadying influence in a field of investigation which tempts to trifling."

The usefulness of the book is greatly enhanced by the illustrations, which are admirably reproduced, and form, perhaps, its most striking feature; and also by the presence of numerous meteorological and other tables, and of a bibliography at the close of each chapter.

For the rest, the translator and the editors are to be congratulated on the successful completion of their task, which adds another standard work to the useful and important series of translations issued by the Clarendon Press.

To the contents of the original German edition have been added an "appreciation" by Prof. Percy Groom, which gives an interesting sketch of the life and work of the late Prof. A. F. W. Schimper; and a frontispiece, consisting of a photogravure portrait of the author, whose "untimely death," to quote once more from the editors' preface, "has robbed the English edition of modifications and improvements which he had intended to make." R. H. Y.

THE COMPARATIVE HISTOLOGY OF VERTEBRATES.

Lehrbuch der vergleichenden mikroscopischen Anatomie der Wirbeltiere. Herausgegeben von Prof. Albert Oppel. Vierter Teil. Ausführapparat und anhangsdrüsen der mannlichen Geschlechtsorgane. By Prof. Rudolph Disselhorst. Pp. x+432. (Jena: Gustav Fischer, 1904.) Price 20 marks.

It is now nearly eight years since the appearance of the first volume of the "Lehrbuch der vergleichenden mikroscopischen Anatomie der Wirbeltiere." In the preface to that volume Prof. Oppel gave an account of the general scope and object of the work, which was to provide a comparative description of the minute anatomy of every organ of the body throughout the entire vertebrate series. Vol. i., which deals with the histology of the stomach and is unequalled for its wealth of detailed information, was followed in the next year by a second part, giving an account of the œsophagus and intestine, while in 1900 the third volume, which is devoted to the consideration of the mouth, pancreas, and liver, and concludes the description of the alimentary tract, was issued. These three very elaborate volumes are from the pen of the editor. But at the outset it was obvious that the task was too gigantic for one man alone, and Prof. Oppel in the preface to the original volume refers to the almost certain necessity of obtaining collaboration. Thus the preparation of the fourth part—the one under review—which deals with the accessory glands and ducts of the male reproductive system, was entrusted to Prof. Disselhorst, and of this volume it is high praise to say that it maintains the level of achievement reached by its predecessors.

The book is divided into seventeen sections, and of these the first fifteen deal with the minute anatomy of the organs, each section being devoted to a particular group or order of the vertebrate phylum. Thus the first two sections contain accounts of the accessory ducts and glands in the two main divisions of the pisces; the third, fourth, and fifth deal respectively with these structures in the amphibians, reptiles, and birds, while the following ten sections comprise descriptions of the same organs in the chief groups of the mammalia. The last two sections consist respectively of a condensed summary of the previous part of the volume and a short sketch of the history of the subject, to which are appended some notes on the physiology of the structures described.

A work like the present is necessarily of the nature of a compilation. Thus there occur frequent references to such books as Oudemans's "Die accessorischen Geschlechtsdrüsen der Säugetiere," and to Prof. Disselhorst's own work on the same subject. The references on the whole are extremely full, but it is inevitable that there should be some omissions. For instance, I find no mention of Dr. Nicolas's "Contribution à l'Étude des Organes érectiles," published in the *Journal de l'Anatomie et la Physiologie* (1887), neither is Garrod's paper entitled "Notes on the Osteology and Visceral Anatomy of Ruminants" (*P.Z.S.*, 1877) referred to, in spite of the fact that it contains the best and indeed practically the only comparative account of the curious modifications undergone by the copulatory organ in the Ruminantia. Perhaps it is hardly reasonable to expect a complete series of references to papers dealing mainly with the anatomy of animals in a book professedly devoted to histology, yet the titles of a great number of less important papers treating in many cases of single species duly appear in the bibliographical lists. It cannot be said, however, that omissions such as those mentioned detract seriously from the value of the book as a whole. It is to be noted that the lists of references, instead of forming one long bibliography at the end of the book, as in the previous parts of the work, in this volume are appended to the various sections, so that the titles of papers referring to any one particular group occur together. The book is copiously illustrated by zincographs and by reproductions from photo. process blocks. In addition to the 435 figures appearing in the text, the chapter on the monotremes and marsupials, which is perhaps the most interesting

and at the same time the most complete, is further illustrated by seven large folding lithographed plates. These are bound at the end of the volume.

Suffice it to say that this piece of work is a matter for congratulation to Prof. Disselhorst, and its publication a credit to all concerned

Francis H. A. Marshall.

SPECTRUM ANALYSIS.

An Introduction to the Study of Spectrum Analysis. By W. Marshall Watts, D.Sc., F.I.C. Pp. vii + 325. (London: Longmans, Green and Co., 1904.) Price 10s. 6d. net.

It is somewhat remarkable that, in spite of the great interest and importance of the subject, there are few, if any, text-books on spectrum analysis which really meet the requirements of beginners who desire to take up the matter practically. The announcement of an introductory work by the well-known compiler of the "Index of Spectra," however, led to the hope that this gap in the literature of the spectroscope would at last be adequately filled, but it is disappointing to find that the needs of the practical student are again almost disregarded.

The book includes a brief account of the optical principles underlying the different forms of spectroscope, and general explanations of the methods of producing and mapping spectra, besides which there are short statements relating to the arrangement of lines in series, and the applications of the spectroscope to the study of the heavenly bodies. When it is stated that nearly half the book is occupied by wave-length tables, and that there are 135 illustrations—many of them large ones—it will be seen that the general treatment can scarcely be otherwise than sketchy. The descriptions of the modes of procedure are consequently often lacking in details which would have been of the greatest use to the student. Thus, with reference to the spectra of gases, the only method of observation indicated is that of a ready-made Geissler tube, which, as the author remarks, does not always show the spectrum of the gas present in the greatest proportion; it would have been useful to explain how the student might examine the spectrum of a gas collected or prepared by himself. Later on, there is a short account of stellar spectra, but no directions whatever as to how such a spectrum may be observed.

Another very serious defect from the student's point of view is the use of the arbitrary scale of Bunsen in the maps and earlier descriptions of the characteristic lines of the different elements. It is afterwards shown how such measurements may be reduced to wave-lengths, but surely it would have been better to define the various lines by their wave-lengths from the very beginning; as it stands, a great deal of unnecessary labour is involved in the comparison of the descriptions and maps with the wave-length tables given at the end of the book.

The book, in fact, leaves a great deal to be desired, whether considered as a laboratory guide or as a descriptive work. Many important facts are left unnoticed, though space might have been found for some of them by the omission of superfluous or insufficiently described illustrations. In the section on nebulæ, for instance, there are no less than eight diagrams showing the telescopic appearances of these objects, but no reference to the fact that all nebulæ do not exhibit bright line spectra; the reader is, moreover, likely to get the wrong impression that the chief nebular line is due to nitrogen.

Though brought well up to date in some respects, the book is far behind the times in others. It is erroneously stated (p. 106) that the spectrum of the solar corona includes lines of helium, hydrogen, and calcium, and the important subject of enhanced lines in relation to many celestial spectra is overlooked altogether.

Many other examples of the shortcomings to which attention has been drawn might be given, but the above will sufficiently indicate that the selection of material has not been judiciously made. By far the most valuable feature of the book is the series of abridged tables of wave-lengths, showing the more important lines in the spectra of nearly all the known chemical elements.

OUR BOOK SHELF.

Text-books of Physical Chemistry.—Electrochemistry. Part i. General Theory. By R. A. Lehfeldt, D.Sc. Pp. viii + 268. (London: Longmans, Green and Co., 1904.) Price 5s.

Students of physical chemistry have to-day no cause to complain of a dearth of books upon the subject. There are a considerable number of large volumes treating of this branch, and now we have the series of text-books edited by Sir William Ramsay. The book under review is the second of the series, and has been entrusted to Dr. Lehfeldt, who is well known as a worker on the physical side of electrochemistry.

Dr. Lehfeldt has not followed any hard or fast line laid down by previous writers upon the subject, and for this reason the book may be read with more than ordinary interest. The book is divided into three chapters, which might perhaps better be designated parts i., ii., and iii. Chapter ii. is written by Mr. T. S. Moore, and deals with the relation of chemical constitution to conductivity. This chapter is very carefully thought out and arranged, and the author has consulted the latest literature. It deals, in the first place, with the relation of charge carried to constitution, this portion being really a repetition and enlargement of what has already been dealt with in the previous chapter. In fact, chapter ii. is to a certain extent an addendum to the first chapter, but it should in no wise be skipped by the student who desires to comprehend the bearing of electrochemistry on chemical problems. Other points treated in this chapter are relation of the number of ions in solution to constitution, pseudo acids and bases, amphoteric electrolytes, and so on.

Chapter i. commences with a description of certain voltameters. We would rather that the author had adopted the term coulommeter, because the instruments are for measuring current and not potential.

although, of course, the author is only using the term commonly applied to these instruments.

Dr. Lehfeldt then discusses the mechanism of electrolytes. We are not sure what a certain school of chemists will say to the following rather didactic statement:—

"It was Arrhenius who first put forward reasons for supposing that an electrolyte might be largely, . . . dissociated in solution . . . this view has gradually gained support from experiment since, and may be looked upon as thoroughly established."

Dr. Kahlenberg, for instance, would hardly subscribe to this statement. In this chapter the author also deals, among other subjects, with the conductivity of the electrolyte, ionic velocities, and electrolysis in non-aqueous solutions.

The last chapter is devoted to the theory of chemico-electromotive force. The section on thermodynamic theory and the calculation of electromotive force of a voltaic cell well repays perusal, as does the section on standard cells.

Dr. Lehfeldt is thoroughly at home with his subject; we are not, however, sure whether the average student will find the style very interesting. Of course, a book of this kind cannot be read in a cursory way; if it could, we doubt whether it would be worth reading, but we are of the opinion that it will be welcomed by all interested in the subject.

Traces of the Norse Mythology in the Isle of Man. By P. M. C. Kermode. Pp. 30. (London: Bemrose and Sons, Ltd., 1904.) Price 2*s*. 6*d*.

In this work Mr. Kermode, whose name is well known in connection with Manx archæology, has printed a lecture delivered to the Antiquarian Society of his native island in December of last year. The Isle of Man contains a large number of cross-bearing gravestones, which, as the inscriptions clearly show, belong to the period when the Scandinavian element was predominant in the island. It is not improbable that in some cases the symbols on these stones may refer to the old Scandinavian mythology rather than to Christian belief and legend, and Mr. Kermode has endeavoured to determine how far this is the case. After a very brief sketch of the Scandinavian settlements in the west, and more especially in Man, a short account is given of some leading details of the old Norse mythology as preserved in the Eddas. Both here and in the following section an interest in the subject is sometimes more evident than familiarity with it in all its bearings. It is, for example, quite erroneous to state that "of the seven days of the week all but the first two are called after Scandinavian gods." Even on his own lines, Mr. Kermode cannot thus account for *Saturday*, and a closer study of the old English forms would have shown him the true origin of the other names. The influence of the Scandinavian tongues on English has been very great, but it requires a close study of philology to decide the particular cases in which it appears.

The concluding section consists of a detailed description of the illustrations, under eight heads, and with references to the ten plates at the end of the booklet. These are neatly executed, and exhibit typical specimens of Celtic crosses and ornamentation, as well as the symbolic figures which Mr. Kermode believes to represent subjects taken from the old mythology. In many cases the explanation he offers is extremely doubtful, as there is always an equal, if not greater, possibility that the symbols are of Christian origin. Thus, what Mr. Kermode takes to be an eagle (=Suttung) pursuing a falcon (=Odin), might equally well, for all one can see, represent Noah's raven and dove. The harper whom he identifies with the "gladsome Eggthér" of *Völuspá* may just as well be King David; and if the fish is a Christian symbol on Plate X., why not also on Plate III.? In many of these cases it is probably hopeless to determine what the sculptor had in his mind, and there is no particular gain in making guesses at it.

In minor points there is not always as much precision as is desirable. The Icelandic words and names are too frequently misprinted, while such equations as *Hnikarr* and *nykr*, *Rig* and *Eirik*, are evidence of shaky philology. Mr. Kermode's lecture, however, may be of service in helping to waken or encourage interest in that Scandinavian influence on Britain which is an important factor in the history of our country.

W. A. Craigie.

Eton Nature-study and Observational Lessons. Part ii. By M. D. Hill and W. M. Webb. Pp. xvi+174. (London: Duckworth and Co., 1904.) Price 3*s*. 6*d*. net.

Part ii. of this book, like part i., is excellent. That nature-study as here recommended is educationally sound is beyond dispute. What makes instruction so wearisome to the learner is often, to put it plainly, the unceasing sound of the schoolmaster's voice. What a boy, if he has any go in him, wants, is to do something for himself. It would be best if he could make out everything unaided. "I never tell my pupils anything," once said a mathematician devoted to the maieutic method; and Hesiod quaintly remarks, "The best man of all is he who finds out everything for himself." But this is hardly possible for us moderns, and the authors of this book are wise enough not to make a craze of a sound principle. In the chapters, to take examples, on earthworms, woodlice, the defensive armour of plants, and plants that have no flower, there is plenty of information given to stimulate interest. If the pupil is the right kind of boy, he will be keen to follow some of the lines of investigation pointed out. Many persons are led to the out-of-doors study of natural history by reading. They want to see some of the wonderful things that naturalists have seen, not always to get them at second hand. Indeed, the importance of reading in connection with observation should be insisted on. Many boys, though full of zeal, never get beyond a very restricted field in natural history, because they will not read in order to discover how the little that they have learnt by the use of their own eyes finds its place in the vast accumulation of knowledge. The observer should be a reader, and the reader an observer.

A great deal may be learnt by trying the experiments recommended in this book, *e.g.* by hatching trout eggs, by keeping a fresh-water aquarium or an observatory hive of bees, by making a formicarium, by photographing such things as birds and birds' nests. But here a difficulty arises. At school, how is a boy to keep an observatory hive of bees or to hatch trout eggs? In fact, some of the suggestions bring out sadly the limitations of school life. Others, no doubt, are quite possible. But headmasters might well study a book like this. If teaching is to proceed on a truer and more natural plan than hitherto, something must be done to remove existing restrictions.

The subjects for observation (*e.g.* a frog's egg, a hen's egg, the development of tadpole and chick, a silk worm, an opening flower) are well chosen. The illustrations are all good. Some of the photographs ought to induce boys to make their photography a help to accurate observation instead of a mere amusement.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Forest-pig of Central Africa.

IT may interest many of your readers to know that the "forest-pig" heard of, at the same time as the okapi, by Sir Henry Stanley, and later on by Sir Harry Johnston, has at last been obtained and presented to the National Museum by Mr. R. Meinertzhagen.

This gentleman first had news of it from the natives of Mount Kenya, and took great pains to secure a specimen, but only succeeded in obtaining pieces of skin, from which no idea of its affinities could be gathered. At last, however, in the Nandi Forest, near the Victoria Nyanza, at an altitude of 7000 feet, he received two skulls, one quite perfect, and some further portions of skin.

These trophies show that the animal represents a most interesting new genus connecting the aberrant wart-hog (Phacochærus) with the more ordinary Suidæ, such as Sus and Potamochærus. It agrees with the first named in the number of its incisors, and shows a tendency towards it in the development of the canines and the structure of the molars. On the other hand, in the general proportions of the skull it is more like Sus.

Altogether, if it cannot be called absolutely ancestral to Phacochærus, it must at least be looked upon as representing an early stage in the specialisation of that most remarkable type.

The animal itself is about as large as a wart-hog, and is well covered with long coarse black hair.

It is proposed to be called *Hylochoerus meinertzhageni*, and I hope to give a full description of it at an early meeting of the Zoological Society.

OLDFIELD THOMAS.

British Museum (Natural History), October 7.

Appeal for Cooperation in Magnetic and Allied Observations during the Total Solar Eclipse of August 29-30, 1905.

THOSE who are in a position to take part in the above cooperative work are earnestly requested to make the necessary preparations and to put themselves in communication with the undersigned.

As this will be the best opportunity for some time to come to test and observe further the magnetic and electric phenomena which have been found to occur in connection with total solar eclipses, and as these phenomena are destined to play an important *rôle* in the theory of those variations of the earth's magnetism and electricity ascribed to outside forces, it is very much hoped that all countries through which or near which the belt of totality passes will organise and send in the field observing parties.

Owing to the minuteness of the expected magnetic effect, the burden of proof as to its association with the eclipse will largely consist, as in the two previous eclipses, in the connection of the times of the magnetic effects with the times of passage of the shadow cone at the various stations. The observing parties, therefore, should be distributed at intervals along as much of the entire belt as possible.

The above is merely a preliminary notification of the work proposed. Fuller details and suggested directions to be followed will be given later.

L. A. BAUER.

Department of Terrestrial Magnetism, The Ontario, Washington, D.C., U.S.A.

Instinct and Reason in Dogs.

THE following statements may be of interest to those of your readers who have at times discussed the question of instinct and reason in dogs.

A friend of mine was in a strange town, having with him an Irish terrier. Finding it necessary to fasten the dog up outside a house, he did so by tying it with a piece of cord. On coming out of the house he was just in time to see his own dog being led away by a strange dog holding the cord in his mouth, having bitten it through. My friend often takes this same terrier, together with a fox terrier, out with him when calling. He ties the fox terrier by a cord to the scraper; as often as not the Irish terrier bites through the cord and frees his friend.

My own fox terrier seldom if ever goes to the stables, and whilst I am absent from home for a few days remains in his usual place; but almost invariably on the day when I am expected back he pays frequent visits to the stable, and is anxious to go with the carriage if he sees it being got ready; at all other times he is not willing to go with the carriage unless I am in it. On the two last occasions when I was expected home the dog acted as previously, but, in addition, jumped into the carriage as soon as it was brought out of the coach-house, a thing which he has never done before.

E. W. P.

October 8.

Misuse of Words and Phrases.

As a constant reader of NATURE and of papers read before scientific societies, I have been struck by what seems to me an inaccurate use of language by English men of science which is rarely chargeable upon Americans—which is, at any rate, at variance with American usage. I will illustrate with the following examples:—

One star is five light-years distant; another is twenty-five light-years distant. The English astronomer will say that the second is *five times farther away* than the first.

A mass of aluminium weighs one pound; a mass of lead of equal size weighs something more than four pounds. The English physicist will say that aluminium is *more than four times lighter* than lead.

Both expressions seem to me incorrect and unworthy of a man of science who endeavours to express himself accurately. In the one case he should say that one star is five times *as far away* as the other. In the other case the whole expression is vicious. Weight, heaviness, is an attribute of matter; lightness is absence, or deficiency, of weight. To say that one article is a certain number of times *lighter than* another is like saying of two vessels unequally exhausted of air that one is four times emptier than another.

It is good English—is it not?—to say that one article is twice as heavy as another. If it is twice heavier, it is three times as heavy.

I submit this criticism of an Anglicism as an offset to some one of many criticisms of Americanisms.

E. S.

Boston, U.S.A.

NATURAL HISTORY ESSAYS.[1]

ON the whole, Mr. Renshaw appears to have been well advised in re-issuing in book form the sixteen articles and lectures which constitute the volume before us, since several of them contain much important information with regard to species now verging on extinction, or which have been already exterminated, while all are eminently readable and full of interest. Whether the author has quite done himself justice in the title he has chosen for his work may be open to question, seeing that all the articles relate to a single subject, namely, the mammals of Africa. Undoubtedly the most generally interesting and important articles of the series are the two dealing with the quagga and the blaauwbok, next to which may perhaps be ranked those on the white rhinoceros, the pigmy hippopotamus, and the giraffe. The book is abundantly illustrated with reproductions from photographs, many of which, like the one here shown, are excellent examples of animal photography.

While there is much to commend in the work before us, there are also matters with which to find fault. In the first place, the author has not revised his articles

[1] "Natural History Essays." By G. Renshaw. Pp. xiv+218; illustrated. (London and Manchester: Sherratt and Hughes, 1904.) Price 6s. net.

so as to bring them up to date. A striking instance of this is afforded by the one on giraffes, which takes no notice of the new forms described in "Animal Life" for 1903, and in the *Proceedings* of the Zoological Society for the present year. A minor instance is the statement (p. 212) that the aard-vark is represented in the exhibition galleries of the Natural History Museum by a specimen mounted in 1841, that specimen having been removed considerably more than a year ago, and replaced by a new one. Again, on p. 56, Mr. Renshaw repeats his statement that an antelope skull in the Museum of the Royal College of Surgeons is that of the extinct blaauwbok, whereas Mr. O. Thomas has expressly stated in the *Field* that it pertains to the roan antelope. If the author adheres to his original view, he should at least have attempted to refute the statement of an expert like Mr. Thomas.

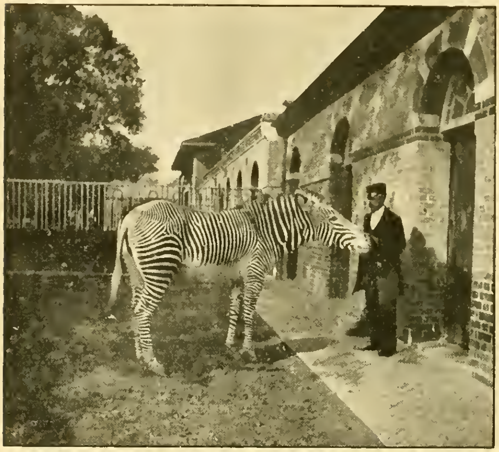


FIG. 1.—A Grévy's Zebra. From Renshaw's "Natural History Essays."

A further instance of what may be called "opinionism" on the part of an amateur is afforded by the case of the quagga in the Natural History Museum, which Mr. Renshaw, in opposition to the museum authorities, believes to be one which was brought to London in 1831. The evidence indicates, on the contrary, that this specimen is without doubt one received by the Zoological Society in September, 1858, which died, or was killed, in June, 1864, and was acquired by the museum in July of the same year, as is indicated by its register number (64.7.2.3). Equally erroneous, unfortunately, is the statement on p. 191 that the Amsterdam quagga was a Knowsley Menagerie specimen, as has been pointed out in a recent issue of the *P.Z.S.* *Per contra,* Mr. Renshaw is to be credited with pointing out that the quagga depicted in "Wood's Natural History" is one of the specimens living in the "Zoo" during the 'sixties, since the figure indicates an animal clearly identical with those represented in the "Knowsley Menagerie," and thus serves to identify the quaggas of the 'sixties with those figured in older works, which have been thought to be different. The reference to a statement made in 1801 as to the protective nature of the markings of the zebra (p. 165) is likewise a point on which the author is to be congratulated.

Reverting to errors, we may direct attention to the misappropriation of the name *Felis pardina* (p. 19) to the ocelot, of which the proper title is *F. pardalis*, *pardina* being the appellation of the Spanish lynx. In popular works the use of scientific names should, in our opinion, be mostly avoided, but if they are used they should be correct; a transposition of names like the above is every bit as bad as calling a lion a tiger! Another example of the necessity for care in the employment of scientific names in works of this nature occurs on p. 133. In one sentence on that page we find the name *Rhinoceros antiquitatis*, and later on the title "woolly rhinoceros," but there is nothing to indicate to the uninitiated that these denote one and the same animal.

If only the author had paid a little more attention to the revision of his articles he might have converted a very interesting volume into a really valuable record of the past history of several extinct and waning forms.

R. L.

DEVELOPMENTS OF THREE-COLOUR PHOTOGRAPHIC PROCESSES.[1]

II.

HAVING obtained the three colour records it remains to use them for locating the colour in the production of the final print. If the coloured lights are to be added, as in Ives's chromoscope, then a transparency is made from each colour record (which is, of course, a negative), and each transparency is made to furnish light of a similar colour to that of which it is the record. If the colours are to be superposed, as when they are printed one over the other, or when coloured transparencies are made and superposed in the method of making coloured lantern-slides, then a complementary colour to that of each record must be used, because the absorptions are added instead of the lights. In the chromoscope the colours are in the form of screens; they remain in the instrument, and therefore are provided once for all. In the other cases they are stains or inks, and an amount is used up in the production of each print; they are therefore used in quantity. In the choice of inks and stains, the perfection of colour is only a matter of degree, and those colours that most nearly approach perfection may not be suitable otherwise. The best colours may be (and in some cases are) fugitive, so that for practical purposes an inferior colour has to be used. If the colour is perceptibly different from the theoretical tint, then the colour records must be adjusted to make the best of the available colours. When the colours are superposed, as in printing on paper, at least two of the three inks must be made of transparent colours, or obviously the top colour would hide those beneath. This last matter is, as Hübl remarks, one of the most important difficulties in trichromatic work, and, he adds, the colour last printed will always predominate over those previously applied. Hübl, in his treatise, describes how to select the inks by means of his circular spectrum colour scheme, and how to mitigate the errors due to the defects of the selected colours, chiefly by retouching and by setting off one defect against another. The inks may be selected also by the use

[1] "The Water-Colour Drawings of J. M. W. Turner, R.A., in the National Gallery." By T. A. Cook. Pp. vi+86 and 58 plates. (London: Cassell and Co., Ltd., 1904.) Price 3 guineas net.
"Three-Colour Photography." By A. F. von Hubl. Translated by H. O. Klein. Pp. 148. (London: A. W. Penrose, Ltd., 1904.)
"Photography in Colours." By R. C. Bayley. 2nd edition. Pp. 151. (London: Iliffe, Ltd., 1904.) Price 1s. net.
Continued from p. 555.

of Abney colour sensitometers, or by spectroscopic methods, but it is not sufficient to judge of the colour by the eye alone. It is necessary that the colours shall not only look right, but that they shall be right when analysed spectroscopically. Each colour is used, not so much for its own sake, as to give the proper tints when the light it reflects or transmits is mixed with the light from the other colours.

But supposing that the inks or stains selected were theoretically perfect in colour, and perfectly transparent, so that when superposed the lowest produced its full effect, it still remains to see that each is laid on in its due proportion, for if one is in error the whole will be thrown out, and what should be neutral greys will be tinted with colour. And there is still another difficulty to consider. The gradation produced by the same treatment of a sensitive plate generally becomes more steep as the wave-length of the light used increases. This is certainly the rule, though there may be exceptions to it. Therefore, if the pink, yellow, and blue inks are properly proportioned to give a neutral black where the colours are in full quantity, the greys may be expected to be bluish, and in the lighter colours there may be expected a deficiency of red. To overcome these difficulties, some have sought to use four, or even five, colours instead of three, and others have used a fourth plate with black ink to give the blacks and greys, removing from the plate those parts where pure colours are required. Obviously, the use of additional printing plates is a confession that the three-colour process cannot be worked on the theoretical lines, but such variations as these do not appear to be at all generally adopted.

There are many methods by which the three colours may be brought together to make the final picture. The simplest of all, both theoretically and practically, and at the same time perhaps the most perfect and therefore the most beautiful, appears to be the production of transparencies by the superposition of gelatine reliefs produced from the colour records, each appropriately stained by immersion in a suitable dye solution. There is nothing to regulate the depth of colour to which each relief should be stained but the judgment of the worker, and the fact that the greys and blacks of the original should be untinted by colour in the reproduction. A relief may be more highly coloured by a further immersion in the dye solution, or lightened by immersion in water.

For printing on paper, either the collotype process, lithography, or typographic blocks may be employed. Some very excellent work has been done by the first of these methods, but in both collotype and lithography, as already stated, it is difficult to regulate, to a nicety, the amount of ink applied, and the successful impressions generally form only a small proportion of the whole. The process that is the most used, and that certainly at the present is the most suitable, consists in printing from typographic blocks as ordinary letterpress is printed. The photographic production of blocks from half-tone negatives is practised to so great an extent, and the machinery for letterpress printing is so perfect, that uniformity is more easily secured by this than by other methods. In pointing out the advantages of this process, Colonel Hübl states that it gives a better blending of the colours, and that the inks are not brought into contact with water so that they remain pure, and as the paper remains dry during the printing a better register is secured. But the process has its own defects—Hübl says that "the gradation is limited and incorrect," and that "the final result depends more on the clever work of the retoucher than on the perfection of the photographic negative." This last statement conveys, perhaps, rather an exaggerated view of the facts of the case.

The dots in the impression from a half-tone block are, as is well known, in lines, as determined by the ruling of the screen that is placed in front of the plate when the grained negative is made. Now when lines at regular intervals cross each other at a small angle a pattern is produced known as a "moire" or "watering" effect, from its similarity to the appearance of "watered" silk. The effect can easily be seen by looking through two pieces of muslin superposed with the threads not quite parallel. Two rows of park railings, if near enough, will often show it, the railings in each row being parallel to each other, but not quite parallel to those in the other row. In superposing three impressions from blocks made by means of cross-lined screens, it is important to avoid any approach to parallelism of any set of lines or rows of dots with any other, especially as regards the relative positions of the red and blue impressions, as these are darker than the yellow, and therefore more conspicuous. It is obvious that if the screen used has its crossing lines at right angles, the three impressions will give six sets of lines, and an angle of 30° between each and the next if the angles of crossing are kept equal. Circular lined screens mounted in aluminium cells, so that they can be rotated to any desired angle with precision, are much used in America and are coming into use here. A common method, which is being superseded by the circular screen, is to use two rectangular screens, one of which is ruled at such angles that, by turning it round from back to front, it gives the rulings in the third position. Other methods are sometimes used for the purpose, for the shape of the aperture in the diaphragm affects the character of the dots, and it is possible to use a slit diaphragm and rotate the lens that carries it. But the most notable variation in the preparation of the blocks is to get rid of the lines, or even rows of dots, altogether, by using an irregular grained screen. Of the many attempts that have been made in this direction, the one that seems to offer the greatest promise of success is Wheeler's "metzograph" screen, in which an irregular wavy surface of the glass gives the concentrations of the light required.

There is one matter in connection with three-colour printing by means of half-tone blocks that sometimes presents a difficulty to the minds of those who have a slight acquaintance with the subject, and certainly is not altogether without effect, namely, the fact that the dots of the different colours are sometimes superposed and sometimes side by side, according to accident in printing. This difference is not very important. The colours are arranged on the supposition that they are superposed. If otherwise, much the same tint results, but it is mixed with white, because the result is the sum of the lights instead of the sum of the absorptions. But if the dots were completely superposed, then there would be a greater area of white paper between the dots, and the white light from this source doubtless about compensates for the other. Perhaps, in the circumstances, the juxtaposition is advantageous, as the tendency for the ink last applied to show more conspicuously than the others would not hold in this case.

A notable example of the excellence that is now possible by three-colour typographic printing may be seen in "The Water-Colour Drawings of J. M. W. Turner, R.A.," a selection of fifty-eight subjects, published by Messrs. Cassell and Company, the reproductions being made by Messrs. André and Sleigh at their works at Bushey. In such a case the question that is naturally asked is, Are the colours of the reproductions similar to those of the original? Of course they are not the same pigments—this is not intended; the only aim of the printer is to give colours

that cannot be distinguished from the original by simple observation. Mr. Theodore Andrea Cook, in his preface to the volume, refers to "mechanical accuracy, assisted and improved by skilfully delicate and reverentially careful handiwork," and thus sums up the position according to the facts of the case. The colours are not accurate by reason of the fact that the printing blocks are made by photographic means, although this may be claimed for the drawing—that is, the outline. In describing the process of three-colour printing, we have endeavoured to show how that imperfection and compromise qualify every step of the work. It is therefore necessary to examine the first proof by critically comparing it with the original, and then to make such alterations as are required in the three printing plates, by re-etching wholly or partially, by hand engraving, burnishing, and similar methods, continuing to make proofs and effect the needed changes until the differences are eliminated. At Messrs. André and Sleigh's this examination and hand work are carried out by trained artists, as distinguished, that is, from photographers and printers, and it is to the scrupulous care bestowed upon this adjustment of the plates by hand that the perfection of the prints depends. The justification lies in the result, and, whatever may be said for or against any principle of work, it is by the practical result only that it can, at present, be finally judged. If a copyist were to paint a copy of a picture, we should naturally seek the opinion of eminent painters as to the merits of the copy. Three-colour reproductions put forward as these are must naturally be judged in the same way, and it is a source of gratification to all interested in the technics of three-colour work to know that these reproductions have received the warm approval of many of our best known painters. But it is easy to believe that there is room for a little difference of opinion, and that a critical comparison with the originals would reveal possibilities of improvement. Such have been pointed out, and presumably no three-colour work will ever be done for which absolute faultlessness can be rightly claimed. But there is a possibility of error even in this criticism. For as the reproduction is not done in the same pigments as the original it follows that the effect of a difference of illumination will not be the same on both. If the reproduction were perfect as compared with the original by ordinary good daylight, there would probably be differences noticeable to a trained eye if they were compared on a dull day; and this probability must exist however the copy is made if the pigments used are different from those in the original. Moreover, no work in colour appears as it is intended to unless it is illuminated by the light by means of which it was produced or a quite similar light, and this is a physical law which must ever obtain.

There have been a few attempts to simplify the three-colour process by the use of one screen only, the three colours being arranged upon it. Perhaps the best known of these is due to Prof. Joly, who arranges his colours in triple parallel lines. The most recent, and the boldest in its conception, has only just been published by Messrs. Lumière. They sort out from potato starch granules from 0.015 to 0.02 mm. in diameter, and colour separate lots of these red, green, and violet respectively. When quite dry the coloured granules are mixed in such proportions that the mass appears grey, with no predominance of either colour, and a waxed glass is coated with them to form a layer only one granule thick. To prevent the interstices from passing white light, they are filled up with a fine black powder. There is next applied a varnish which has as nearly as possible the same refractivity as the starch. By this means is obtained an irregular-grained triple-colour screen. To prepare it for producing the picture it is coated with a suitably sensitised emulsion. The plate is exposed through the glass, developed, the silver image dissolved away, and the remaining silver salt reduced to the metallic state to form the image. Thus is obtained the completed transparency. It is obvious that if such plates ready for exposure were supplied commercially, the making of coloured transparencies would be much more simple than when three negatives and three prints have to be made. There must be many practical difficulties to surmount in the preparation of such compound plates, and, as in all cases of three-colour work, the process must at present be judged by the results that it yields rather than by the apparent soundness or otherwise of the theories upon which it is based.

The small volume by Mr. R. Child Bayley forms a good introduction to the subject of colour photography, as it is written in such simple language that it may be "understood and followed by any reader, even by one without the slightest acquaintance with photography," as the author states in his preface. At the same time sufficient formulæ and precise details are given for the practical working of those processes that are within the experimental possibilities of the photographer.

CHAPMAN JONES.

NOTES.

THE French physicians and surgeons who are visiting London arrived on Sunday. On Monday the president and council of the Royal College of Surgeons received the visitors, who were shown the collections in the museum. Parties have during the past three days visited the principal hospitals, general and special, the physiological laboratories of the University of London and the laboratories of the Cancer Research Fund, the Lister Institute, the Middlesex Hospital cancer department, the pathological laboratory of the County Council Asylum at Claybury, and the London School of Tropical Medicine. Receptions have been given by the editors of the *Lancet*, Dr. and Mrs. Dundas Grant, and the Dean of the Faculty of Medicine of the University of London and Mrs. Butlin. On Wednesday night the visit was brought to a close by a banquet at the Hotel Cecil.

THE Government of the Federated Malay States has decided to establish an agricultural department in Malay, and has appointed Mr. J. B. Carruthers, the Government mycologist and assistant director of the Royal Botanic Gardens of Ceylon, to be director of agriculture and Government botanist. The Federated Malay States have an area of more than 25,000 square miles, and the agricultural potentialities are very promising. Large areas are being planted with rubber plants, and sugar and cocoanuts are extensively cultivated. There are two botanic gardens and a rubber experiment station in the Malay States, and all three are, we understand, to be administered by the new department.

ON October 6 the Antarctic relief ship *Morning* arrived at Plymouth from Lyttelton after an absence of about two and a half years.

THE first monthly general meeting of the new session of the Institution of Mechanical Engineers will be held on Friday, October 21. A paper by Mr. R. M. Neilson on "A Scientific Investigation into the Possibilities of Gas Turbines" will be read and discussed.

ACCORDING to the Paris correspondent of the *Daily Chronicle*, Dr. Laveran, of the Pasteur Institute, has discovered a remedy for sleeping sickness, and has already tried it with success upon animals previously inoculated with the disease.

AT the meeting of the Royal Microscopical Society on Wednesday, October 19, a demonstration entitled "The Re-construction of a Fossil Plant" will be given by the president, Dr. Dukinfield H. Scott, F.R.S.

A REUTER telegram from Paris states that a radiographic station has been opened at Ushant for the purpose of communicating with ships at sea. The station will transmit messages from the mainland, and will receive messages for addresses in France, Algeria, Tunis, Monaco, and Andorra.

THE *Chemist and Druggist* states that a congress of chemistry and pharmacy, organised under the auspices of the Pharmaceutical Association of Liège and the Chemical Society of Belgium, will be held in connection with the International Exposition to be held at Liège in July, 1905. Communications should be addressed to one of the secretaries, M. J. Raymond, 16 Place des Carmes, Liège, or M. J. Wauters, 83 rue Souveraine, Brussels.

THE Childhood Society announces that a course of four public lectures will be delivered at the Parkes Museum, Margaret Street, W., on Thursday evenings at 8 p.m. The dates, subjects, and lecturers are:—on October 20, discussion on physical deterioration, to be opened by Mr. E. W. Brabrook, C.B.; on October 27, physical condition of working class children, by Dr. T. J. Macnamara, M.P.; on November 10, mental hygiene in childhood, by Dr. T. B. Hyslop; and on November 24, education of girls, by Miss M. E. Findlay.

THE session of the London School of Tropical Medicine was opened on Friday last with an inaugural address by Sir Charles Bruce, G.C.M.G., ex-Governor of Mauritius, Sir John Craggs presiding. Sir Charles Bruce detailed some of his experiences in the colonies, and gave interesting particulars, from the layman's point of view, of tropical diseases with which he had come in contact, notably the remarkable outbreaks of malaria and of surra in Mauritius. Sir Patrick Manson, in the course of proposing a vote of thanks, directed attention to the munificence of Sir John Craggs in giving a scholarship and prize to the school, and expressed a hope that funds for endowment might soon be forthcoming.

IN the October number of the *Century Magazine* Mr. Gilbert Grosvenor, in an article entitled "Inoculating the Ground," describes the method of preparing and using the cultures of nitrifying micro-organisms which are now being employed as fertilisers under the name of nitragin; photographs are given of two plots side by side, one of which had been planted with inoculated and the other with uninoculated seeds, also of the average plants from each plot. There is a surprising difference between the two, the crop from the inoculated plot being much the more luxuriant, and Mr. Grosvenor expresses the opinion that there is not a section of the United States which will not profit by the use of nitragin.

THE New York correspondent of the *Lancet* announces that the Bureau of Chemistry of the National Department of Agriculture is about to establish a laboratory in New York for the examination of imported foods and the detection of adulterations and imperfections. The occasion which led the national authorities to create this laboratory was the result of a recent investigation which proved that in the last two months three shiploads of food products imported into New York were returned to the ports whence they came on account of the adulterations found. The new law requiring a thorough examination of the food products imported into the United States is being rigidly enforced, and this new laboratory is a proof that the investigation is to be on a large scale.

WE have seen with regret the announcement of the death of Mrs. Isabella Bishop, the well known traveller and author, at the age of seventy-two. Mrs. Bishop was the eldest daughter of the Rev. Edward Bird, and became a traveller on account of her continued ill-health. A visit to Prince Edward Island resulted in her first book of travel. Later sea voyages were ordered to the Mediterranean, America, Australia, and New Zealand, and Miss Bird returned by way of the Sandwich Islands, where she spent some months, and she also visited the Rocky Mountains, describing her adventures in two books which were published in 1873 and 1874. Miss Bird next began her travels in the East. She seems to have been the first European woman who made her way into the heart of Japan, and her "Unbeaten Tracks in Japan" (1880) records her experiences. Her "Journeys in Persia and Kurdistan," in two volumes, appeared in 1892—the year when she was elected the first lady fellow of the Royal Geographical Society—and "Among the Tibetans" in 1894. In 1896 she published an interesting collection of photographs which she had herself taken in western China and Korea. Her travels in Korea, Siberia, and China lasted for three years, and their results are shown in "Korea and her Neighbours" (1898). Since then have appeared from her pen "The Yangtse Valley and Beyond" (1899), and "Pictures from China" (1900).

PROF. FRIEDRICH RATZEL, whose death occurred on August 9, was one of the foremost in the band of ardent geographical students who have done so much, on the Continent at least, to win for their subject recognition, both as a valuable intellectual discipline and as a fundamental part of the training of all who aspire to a leading place in public affairs. While not confining himself to any one branch of the subject, it is as an exponent of the geography of man that Ratzel will be principally remembered. By his development and clearer definition of the principles enunciated by Carl Ritter and his school, of the influence exercised throughout human history by natural environment, he may almost be said to have created a new department of study, which, under the somewhat clumsy name of anthropogeography, has taken a firm hold in the educational curricula not only of Germany, but of France and other European countries, while his influence has likewise been felt, if in a less degree, in our own country. Brought up as an apothecary's assistant, Ratzel seized every opportunity of improving his scientific knowledge, zoology being in these early days his favourite study. But it was as a travelling correspondent (1869–75) in central and southern Europe, in the United States, Mexico, and the West Indies that his geographical leanings first found scope, the utilisation of which brought him eventually, as university professor, to the distinguished chair at Leipzig, where for the rest of his life he continued to exercise a predominant influence on the progress of higher geographical education in Germany. In addition to his "Anthropogeographie," by which he is perhaps best known, Ratzel was the author of important works on the United States, on the races of man, and on political geography from the comparative standpoint.

In its September issue, the *Field Naturalists' Quarterly* publishes the first two of a series of plates (reproduced from photographs) illustrative of the development of the frog. Among the other contents, we may allude to an illustrated article by Miss O. Hill on the acquisition of a portion of Ullswater for the nation, and to the fifth part of Mr. J. L. Kershaw's "The Naturalist in China," which is illustrated with exquisite portraits of the "rainbird" and the Chinese francolin.

THE *South-Eastern Naturalist* for the current year contains Mr. F. W. Rudler's presidential address to the South-Eastern Union of Scientific Societies, in which, after allusion to several points connected with the geology of the district, reference is made to the future of these and similar bodies. Now that many local societies have been relieved of the custody and up-keep of their museums by the county councils, it has been suggested that their work is practically over, and that they should prepare for winding-up their affairs. With this the president does not agree, pointing out that local societies have plenty to do in cataloguing the natural history and archæological products of their respective districts, to say nothing of recording the meteorology. The volume includes notes on the Lepidoptera of mid-Kent by Captain Savile Reid, and a list of localities for uncommon plants by Mr. W. H. Griffin.

PARTS ii. and iii. of the thirty-second volume of Gegenbaur's "Morphologisches Jahrbuch" contain several important papers on vertebrate morphology. In the first of these Dr. K. Kjellberg reopens the question of the homology of the various elements in the articular region of the jaw of mammals and sauropsidans, devoting special attention to the meniscus of cartilage found between the mandibular condyle and the glenoid cavity of the squamosal in many mammals. The author considers that the quadrate of sauropsidans represents the incus of mammals, and the articular of the former the malleus of the latter. The mammalian meniscus is, on the other hand, to a great degree a new element, since it is formed by the cutting off of the upper part of the external pterygoid muscle as it passes between the jaw-articulation to the malleus (its connection in the Sauropsida being with the articular). In another article Dr. A. Schumann points out the curious parallelism between the osteology of the hind-leg of the jerboa and that of birds. In a third Prof. H. Dexler describes the histology of the central nervous system of ungulates, while in a fourth Messrs. Fleischmann and Blendiger discuss the cribriform bones of the nasal cavity of mammals. A fifth article, by Dr. U. Böhi, is devoted to the study of the visceral cavity and genital appendages of the salmon.

IN the third part of vol. lxxvii. of the *Zeitschrift fur wissenschaftliche Zoologie* Mr. L. Freund describes in detail the osteology of the flippers of the dugong as displayed in "sciograph" pictures, of which several are reproduced in the plates accompanying the article. It has long been known that the carpus of the adult consists of three large bones. Of the two in the first row, the one is now shown to consist of the fused radiale and intermedium, and the other of the ulnare plus the pisiform and the fifth carpale, the distal bone being composed of the four inner carpalia. In the manati the reduction of the carpus has been carried to a less extent, the radiale being in some instances distinct from the intermedium, while in other cases in which these two bones are fused the four inner carpalia remain separate. Studies in the oligochæte worms by Mr. A. Ditlevsen, and investigations into the development of the eye of the bee by Mr. O. Dickel, complete the contents of this number.

In the fourth and concluding number of the same volume special reference may be made to a richly illustrated article by Dr. E. Mascha on the minute structure and development of the flight-feathers of birds. It is specially noteworthy that cells of two types are found in the medulla of the quills, those of one type being very common, while those of the second occur in the owls and the nightjars—a feature confirming the alliance of these two groups. Elaborate diagrams of the different types of feather-structure characteristic of various groups illustrate the memoir.

A PRICE list of botanical apparatus has been recently received from Messrs. Gallenkamp, Sun Street, Finsbury Square. The apparatus required for plant physiology is a special feature, and the various pieces have been prepared in accordance with Detmer's practical book. A particularly useful item is a standard barometer which is priced at *3l. 7s. 6d.*, working on the Fortin principle.

THE latest number of the *Records* of the Botanical Survey of India, vol. iii., No. 1, contains an account by Captain A. T. Gage of the vegetation of the district of Minbu, in Upper Burma. The district shows three distinct regions, a mountainous zone of the Arracan Yomahs and parallel ridges, an alluvial belt fringing the Irawaddy, most of which is under cultivation, and an intermediate desert zone, which lies between the two former. The systematic census is confined to the plants collected on an expedition which only extended over one month. A list of economic and medicinal plants is appended.

THE exact nature and purpose of the spines which bristle on the surface of so many Cactaceæ and similar xerophytes must have puzzled many observers and have not been satisfactorily determined. Dr. Darbishire takes up this subject in the *Annals of Botany* (July), and bases his views on an investigation of *Mamillaria elongata*. His conclusions do not coincide with previous explanations, but he gives reasons for maintaining that the tubercle, from which the spines arise, represents a leaf base, and possibly also a part of the stem, while the spines are modified portions of the leaf-blade, and act as a *paraheliode* or screen against excess of sunlight.

WE have received from the Deutsche Seewarte the results of meteorological observations made at selected stations for the lustrum 1896–1900, and for the twenty-five years 1876–1900. The results for each lustrum, from 1876 to 1895, have been previously published; the present volume differs from those which have already appeared by giving the dates on which the extreme values were observed. A table has also been added showing the average number of days in each month, and for each station, on which the rainfall has exceeded 0·2 mm. (0·008 inch). The work is a valuable contribution to the climatology of the German Empire.

AT the jubilee meeting of the Central Meteorological Office of Vienna on October 26, 1901, the Minister of Public Instruction promised that the meteorological results of the previous fifty years should be published in a monumental work, giving an exhaustive representation of the climate of the various parts of the Austrian Empire. The first portion, dealing with the climatology of Lower Austria, has been published by the Vienna Meteorological Office, and has been prepared by Hofrath Dr. Hann, formerly director of the Austrian Meteorological Service, to serve as a pattern for the future discussion, on a uniform plan, of the meteorology of the fifteen other provinces. It is obvious that such a gigantic work would be beyond the powers of any one individual, and it is also desirable that the discussions relating to various districts

should be prepared by persons who have lived in them and have made special studies of the varied conditions of climate. Undoubtedly no meteorologist living could be found who is better qualified than Dr. Hann, whose laborious works are well known to our readers, to prepare a pattern for the guidance of the persons undertaking the subsequent parts. His memoir embraces 104 pages, containing fifty years' monthly and yearly means of different localities, a general summary, and special discussions of the more important phenomena. The work is in every respect worthy of the very high reputation of its author.

An interesting note on the form of Britain, as described by Tacitus, is contributed to the Lombardy *Rendiconti* (xxxvii., 16) by Prof. Giovanni Ferrara, who considers that, of all the Romans, Tacitus had the clearest ideas as to the configuration of our island, and that Ptolemy's map was to a large extent founded on his descriptions.

Prof. Luigi Gabba, writing in the Lombardy *Rendiconti*, (2) xxxvii., 16, discusses the problem of teaching chemistry for technical purposes in Italy, and strongly supports the recent resolutions proposed at the Turin Congress of 1902 by Prof. Cannizzaro urging the Government to provide instruction in technical chemistry, in addition to the existing university instruction of a more theoretical character.

The learning of modern languages is of such importance to science workers that interest attaches to Prof. Charles C. Ayer's paper on the subject in the University of Colorado *Studies*. The author considers that the ability to speak a foreign language fluently depends very largely on a kind of dramatic instinct or power of imitation which seems to project the speaker into a new and foreign personality, and he instances the case of Americans who return from a comparatively short residence in England, letter perfect in the English pronunciation, vocabulary, phrasal intonation, and English manner generally.

What is the "Codex Atlanticus"? is a question which Signor Luca Beltrami answers in a paper reprinted from *Lettura*, and published at the offices of the *Corriere della Sera* at Milan. The name has been given to one of the most interesting works of Leonardo da Vinci, on account of its resemblance in form to an atlas. In 1637 it was given to the Ambrosian Library at Milan, and a reprint has now been produced under the auspices of the Reale Accademia dei Lincei, of which Messrs. Hoepli, of Milan, have a few copies still in their hands. The thirty-five parts occupy more than 1300 pages, and contain 1384 heliotype illustrations, many of them in colours. The edition was limited to 280 copies, the first of which was presented to President Loubet on his visit to Milan. The work of transcription was undertaken by Dr. Giovanni Piumati, and an interesting feature of the first part is the preface, written by the late Prof. Francesco Brioschi, describing the history of the "Codex" from the death of Leonardo da Vinci to the present date.

M. Charles Féry describes in the September part of the *Journal de Physique* a convenient form of telescope pyrometer for measuring temperatures between 500° and 1200°. The heat rays are concentrated by a silvered concave mirror upon a thermo-couple placed at its focus; the reading of a galvanometer connected with the thermo-couple gives the temperature, and the instrument is so designed that the indications are independent of the dimensions of the source of heat and its distance.

The August number of the *Physical Review* contains an interesting note by Mr. W. Coblentz on the infra-red absorption spectrum of selenium. Whereas commercial selenium, which contains sulphur, gives immediately after fusion and re-solidification an absorption which rapidly and regularly increases from 1μ to 14μ, after two days it shows nearly a constant transmission throughout the whole of the same range. This peculiar change in transparency is not observed with pure selenium, as the same transmission curves are obtained immediately after solidification and after an interval of thirty days. It is a striking fact that the transmission curves of sulphur are totally different in character from those of selenium.

A paper by Mr. F. E. Hackett on the photometry of the *n*-rays, which is published as part x. of vol. viii. of the *Transactions* of the Royal Dublin Society, appears at a very opportune moment. In view of the failure of Profs. Rubens and Lummer to reproduce M. Blondlot's results, and Prof. R. W. Wood's strictures on the methods hitherto employed in their investigation, a method for their quantitative measurement becomes particularly worthy of notice. Mr. Hackett has studied the variation of sensitiveness over the retina when habituated to darkness, and claims to have eliminated in this way all subjective variation. The method of measurement adopted shows that whilst the *n*-rays emitted by unannealed glass cause an increase of approximately 10 per cent. in the brightness of a phosphorescent screen, the increase produced by a silent tuning fork is very small, being about 3 per cent. The experiments described are stated to be of such a nature that any person without special training with a little patience may reproduce them.

In the August number of the *Physical Review* Mr. K. E. Guthe has made a comparative study of the various types of silver voltameters which are used for measuring the strength of electrical currents. From the measurements which are recorded it appears that there are two distinct classes of silver voltameters, one class including the ordinary type and Leduc's modification, the other Richard's and the "large anode" types. The voltameters of the second class give a deposit weighing about 0·05 per cent. less than that given by the first class. It appears that in those types of voltameters in which the anode is enveloped merely by filter paper or muslin, the heavy liquid surrounding the anode penetrates through and reaches the kathode, depositing there a complex silver ion. As a consequence, the observed increase in weight is greater than that corresponding with the true electrochemical equivalent of silver. In Richard's voltameter and the "large anode" modification, the deposition of a complex ion is prevented by surrounding the anode with a porous pot so as to exclude contact between the anode-liquid and the kathode. As in this case the variation in the amount deposited by the same current in various experiments does not exceed 1 in 10,000, it is recommended that, in future, the "legal" form of silver voltameter should be superseded by the improved form. A re-determination of the electrochemical equivalent of silver gave a mean value of 1·11683 mg. per coulomb.

The publication committee of the Chemical Society has adopted the word "radicle" in the place of "radical" in their publications. The alteration does not meet with the approval of a hundred and seventy-nine fellows of the Society, who have addressed a letter to the president of the society asking him to bring the matter before the publication committee with a view to its alteration. The signatories point out that:—(1) The new word "radicle" does not convey the sense which the authors of the word

"radical" intended, or that which is still attached to it in chemistry. (2) The use of "radical," though coming through the French, can be defended on purely philological grounds. (3) The original word should be retained out of regard for its historical origin for the same reason that we still employ the word oxygen, although the original meaning has been modified. (4) The original word "radical" is still retained by continental countries and America, and it is only in this country that the change has been made.

MESSRS. F. H. PARSHALL and H. M. Hobart have in hand a work on electric traction which will shortly be published by Messrs. Constable and Co.

A SECOND, revised edition of Dr. C. B. Davenport's "Statistical Methods with Special Reference to Biological Variation" has been published by Messrs. John Wiley and Sons in New York, and by Messrs. Chapman and Hall, Ltd., in this country. The first edition of the book was reviewed in our issue of December 14, 1899, when the opportunity was taken to suggest one or two directions in which improvement was desirable. In addition to the adoption of some of these suggestions, Dr. Davenport has embodied many of the new statistical methods elaborated by Prof. Karl Pearson and others in the new edition of his work.

THE new edition of Dr. A. R. Wallace's work on "Man's Place in the Universe," which has just been published by Messrs. Chapman and Hall, Ltd., at the price of six shillings, contains an appendix in which an argument based on the general theory of organic evolution is used to support the conclusion arrived at as to the unique development of man in the material universe. With this exception, the work remains practically in its original form; for Dr. Wallace remarks that few errors in his facts or fallacies in his conclusions have been brought under his notice, while as to the argument, no student of science has dealt with it in any detail, and "no biologist appears to have thought it worthy of careful consideration."

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A NOVA OR A NEW VARIABLE.—*Circular* No. 68 from the Kiel Centralstelle announces the discovery of a nova or a new variable star by Mr. Stanley Williams, of Hove, on September 20.

The object was first observed on a photograph taken with a 4·4-inch portrait lens between 15h. 59m. and 16h. 23m. (G.M.T.) on the date named, and was then of about the ninth magnitude, its approximate position being:—

$$\text{R.A.} = 22\text{h. } 19{\cdot}0\text{m., dec.} = +29^\circ\ 44'\ (1855).$$

Eleven other plates of the same region, taken between September 27, 1899, and January 16 this year, show no trace of any object in that position, although most of them show stars of the eleventh magnitude or fainter, whilst two plates show stars down to the thirteenth magnitude.

On October 3 the star was observed visually with a 6·5-inch reflector, and was estimated as being about one quarter of a magnitude fainter than B.D. $+29^\circ.4655$ (9·1 mag.). Its colour was recorded as intensely red, almost crimson, and was not unlike that of Nova Persei at the epochs when that object became red.

The above position lies in the constellation Pegasus, about 2° south of the middle of the straight line joining η and π Pegasi.

THE LICK OBSERVATORY PROGRAMME FOR NEXT YEAR'S SOLAR ECLIPSE.—Mr. William H. Crocker has generously undertaken to defray the cost of the Lick Observatory expeditions to observe the total solar eclipse of August 30, 1905. Three expeditions will be fitted out, one going to Labrador, another to Spain, and the third to Egypt.

At each of these stations the programme will include a photographic search for an intramercurial planet and the photographing of the corona with a camera of 5 inches aperture and 40 feet focus.

The Spanish expedition also proposes to make a study of the polarised light in the corona, and to obtain spectrograms of the sun's edge at second and third contacts and of the green coronal line; the latter are to be used expressly for the measurement of the wave-length of that line.

Attempts will also be made to secure spectra of the "flash" and of the general light of the corona at both the Spanish and the Egyptian camps (*Science*, September 23).

VISUAL OBSERVATION OF PHŒBE.—Whilst searching for Saturn's ninth satellite, Phœbe, with the Yerkes 40-inch telescope on August 8, Profs. Barnard and H. H. Turner found an object resembling a star of about 15·5 or 16·0 magnitude the apparent place of which at 18h. (G.M.T.) was

$$\text{R.A.} = 21\text{h. } 23\text{m. } 1{\cdot}0\text{s., dec.} = -16^\circ\ 36'\ 8''.$$

On September 3 Prof. Barnard found that the object was missing from this place.

As the Harvard ephemeris for the satellite gives the approximate place on August 8 as

$$\text{R.A.} = 21\text{h. } 23\text{m. } 0\text{s., dec.} = -16^\circ\ 36'{\cdot}4,$$

the above was probably the first visual observation of this object.

An editorial note attached to the paragraph in the *Astronomische Nachrichten* (No. 3970) in which the above information is recorded enters a *caveat* as to the actual correctness of the figures given, because the manuscript received was very badly blotted.

THE ORBIT OF CASTOR.—A graphically determined orbit of Castor was published in No. 3525 (1898) of the *Astronomische Nachrichten*, but since its publication Prof. Doberck, of Hong Kong Observatory, has determined the three sets of possible elements given below by purely analytical methods, and now publishes them in No. 3970 of the same journal, together with a five-yearly ephemeris calculated from the set of elements No. 4.

The observed angles can be represented equally well by orbits having periods of 200 to 600 years, or even more, but the observed distances are best given by the No. 4 set of elements, which also appears to represent correctly the present decrease in distance.

Elements.

	III.	IV.	V.
Ω =	$29^\circ\ 29'$	$33^\circ\ 56'$	$42^\circ\ 34'$
λ =	$84^\circ\ 44'$	$82^\circ\ 26'$	$118^\circ\ 11'$
γ =	$73^\circ\ 3'$	$63\ 37'$	$61^\circ\ 56'$
e =	0·7513	0·4409	0·2321
P =	268·16 years	346·82 years	501·80 years
T =	1936·65	1969·82	1963·30
a =	$7''{\cdot}3265$	$5''\ 756$	$6''{\cdot}467$

According to the ephemeris, the position angle at the beginning of 1900 was $225^\circ{\cdot}72$, and the distance was $5''{\cdot}627$; at the commencement of 1905 the corresponding figures will be $223^\circ{\cdot}58$ and $5''{\cdot}564$.

In the same publication Prof. Doberck gives a set of elements, and a yearly ephemeris, for the orbit of ζ Sagittarii.

THE MEETING OF THE ASTRONOMISCHEN GESELLSCHAFT, 1904.—In No. 3970 of the *Astronomische Nachrichten* Herr Elis Strömgren gives a brief outline of the papers read at the meetings of the Astronomischen Gesellschaft, which took place at Lund on September 5–8 under the presidency of Prof. Seeliger. Numerous reports of the work suggested by the committee were given by the observers by whom it had been undertaken.

Among these there are reports by Herr Albrecht on the International Latitude Service, by Herr Müller on the catalogue of variable stars, and many others.

ENGINEERING AT THE BRITISH ASSOCIATION.

AT the conclusion of the president's address an interesting function took place. Dr. Schröter, on behalf of the German Society of Civil Engineers, presented to Mr. Parsons the society's gold medal. Dr. Schröter, in making the presentation, directed attention to the conspicuous part which had been played by the president in the advancement of science and its application to practical purposes, and he mentioned that the society which he represented consisted of no less than 19,000 members, and they were proud to think that they were the first engineering society to recognise by a public award the man to whose genius the success of the steam turbine was due.

The afternoon of this day of the meeting, Thursday, August 18, was devoted to a lecture by Mrs. Ayrton on the origin of sand ripples. The lecture drew a very large audience, and was illustrated by lantern slides, diagrams, and by a number of most interesting experiments. The experiments were carried out by means of tanks with glass sides, which were caused to reciprocate, and waves were thus set up; the actual formation of ripples could, therefore, be seen going on. Mrs. Ayrton was of opinion, and showed this fact by some of her experiments, that when water was flowing quite steadily in one direction, that is, without oscillation or wave motion, and without any disturbance, sand ripples could not be produced, and that such a flow of water over previously existing sand ripples would tend to obliterate them. It may be mentioned that on this point she disagrees with Prof. George Darwin, who gave one of the evening lectures, and dealt with the same subject.

The first three papers taken on the morning of Friday, August 19, were concerned with internal combustion motors, viz. flame temperature in internal combustion motors, by Mr. E. Dugald Clerk; the specific heat of gases at high temperature, by Prof. H. B. Dixon; and the calorimetry of exhaust gases, by Prof. B. Hopkinson. Mr. Clerk, in the introductory portion of his paper, stated that had we lived in a world of a much denser atmosphere, there was every probability that the internal combustion engine would have developed on somewhat different lines, that is to say, that the non-compression engine would have been much more successful. The author then described a method he had introduced by which it was possible to reduce the maximum temperature reached in the engine at the time of explosion and still maintain throughout the working stroke a high average pressure, the principle upon which he worked being to produce, as it were, an artificially increased atmospheric pressure. An additional charge of air, compressed by a pump, passed into the cylinder after the working charge had been completely drawn in, and Mr. Clerk showed that in one set of experiments he was able to increase the thermal efficiency from 28·7 per cent. to 34·4 per cent., reducing at the same time the maximum temperature from 1700° C. to 1200° C. The National Gas Engine Co. had constructed to his designs an engine of 300 h.p. to use producer gas, in which this system of air supercompression was used; the front end of the cylinder was arranged to act as the pump for compressing this additional air supply, and the pressure of the charge was raised by this means about 7 lb. per sq. inch above the atmospheric pressure. Mr. Clerk also utilised some of this compressed air for scavenging purposes.

Prof. Dixon in his paper dealt with the experiments he has been carrying out for many years on the specific heat of gases at high temperatures. He stated he had proved that it was impossible completely to burn carbonic oxide gas at very high temperatures. He had found as a general result of his experiments that in the case of carbonic oxide the specific heat rose with the increase of temperature up to a certain point, and then dissociation began. Prof. Dixon then described by means of blackboard diagrams some exceedingly beautiful methods of photographing actual explosions when taking place in glass tubes. Prof Hopkinson's paper dealt with a method of measuring by means of a calorimeter the heat passing away from an internal combustion engine in the exhaust gases. The exhaust gases were cooled down in this calorimeter from the exhaust temperature to atmospheric temperature, and therefore the amount of heat they carried away from the engine could be accurately determined. He suggested that it might be possible with this method to carry out thermodynamic tests of large internal heat engines more accurately than by the method hitherto adopted, in which the heat given to the engine per unit of time was calculated by the aid of calorimeter experiments on the combustible gases employed in working the engine. The only item in the heat account which was not determined in his method was the small loss due to radiation. The indicator cards, or the brake, gave exactly the amount of heat converted into useful work, the amount of heat sent away in the jacket water was easily measured, and by this new calorimeter the amount of heat carried off in the exhaust gases could now be determined. It was pointed out in the discussion that this method of determining the heat required in a given time by a heat engine by measurement of the exhaust waste was analogous to that introduced by Hirn in the case of steam engines many years ago. Papers by Mr. J. W. Hayward on receiver drop in a compound engine, and by Mr. A. H. Peake on superheated steam, concluded the day's programme.

Monday, August 22, as usual, was devoted to the electrical papers, and the proceedings opened with a paper by Mr. A. A. Campbell Swinton on electricity from water power. The author stated that he had been able to obtain accurate statistics which showed that about 1,500,000 h.p. for electrical work was now generated by water power, nearly one-third of this huge total being in the United States, while the total for Great Britain was only about 12,000 h.p. He considered, therefore, that in all probability the real amount of water horse-power devoted to this purpose at the present time would be nearly 2,000,000, equivalent to a coal saving of nearly 12,000,000 tons a year. After giving some details of long distance transmissions abroad, he described two or three systems now at work in Great Britain, and then dealt with the water-power schemes with which he was officially connected, which had been undertaken by the Scotch Water Power Syndicate. In this scheme it is intended, first, to make use of Loch Sloy, which is about 757 feet above Loch Lomond; a dam will be built to raise the level of the loch by about 60 feet; the power-house is to be built on the shore of Loch Lomond at Inveruglas, and overhead wires will convey the electric current to the industrial districts of the Vale of Leven and the Clyde. The author estimated that about 50 per cent. to 58 per cent. of the total energy of the water would be delivered to the customers after making allowance for all the losses in the pipe lines, turbines, dynamos, transmission lines, &c. The company intends to employ from the start a pressure of 40,000 volts in view of the fact that it has powers for a considerable extension of its scheme in the future, when the demand for power justifies it. The total cost of the Loch Sloy scheme was estimated at 200,000*l.*, and assuming 5000 h.p. delivered, this comes to about 40*l.* per h.p. everything included, a comparatively low figure.

The next paper, by Messrs. C. H. Merz and W. MacLellan, entitled "The Use of Electricity on the North-Eastern Railway and upon Tyneside," gave an account of the first important transformation of a steam locomotive-worked railway into an electric railway; the North-Eastern Railway Co. has adopted this latter method for the whole of the suburban passenger traffic on the north side of the Tyne. The company decided to use the third rail and continuous current system, the electricity being generated as a three-phase alternating current at a pressure of 6000 volts. At five substations this is converted into a continuous current of 600 volts. The service given on all the line will be practically quarter-hour trains, except on the riverside line. The electrical energy is obtained from the Newcastle-on-Tyne Electric Supply Co., and Parsons steam turbines, each of them having a normal capacity of 7000 electric horse-power, have been adopted by this company at their Carville power station; these are by far the largest steam turbines at present at work in this country. The authors stated that preliminary tests have shown that the steam consumption would not exceed about 12 lb. per electrical horse-power hour at any load between 4000 I.H.P. and 7000 I.H.P.

Messrs. W. M. Mordey and A. G. Hansard then read a paper on energy losses in magnetising iron, and described

the method they had adopted for measuring by a watt meter the total losses due both to hysteresis and eddy currents.

Dr. W. E. Sumpner and Mr. R. W. Weekes, in a paper on the Hopkinson test as applied to induction motors, stated that they had found Dr. Hopkinson's well known method, with certain modifications, so satisfactory in testing induction motors that they considered it was desirable to direct attention to the experimental details and to give particulars of the arrangements of the machines and the instruments needed for the test, and of their methods of determining the belt losses. In an appendix the results obtained in testing three-phase motors by this method were given.

Dr. W. M. Thornton contributed a paper on distribution of magnetic induction in multipolar armatures. The object of this paper was to discuss the best methods for determining the most suitable radial depth of an armature core for either continuous or alternating machines.

The last two papers dealt with on August 22 had reference to standards of light. Prof. J. A. Fleming, in his paper entitled "Large Bulb Incandescent Electric Lamps as Secondary Standards of Light," described a method he had devised of using as a secondary standard of light an incandescent filament fixed in a large bulb about 12 centimetres in diameter and about 20 centimetres long. The use of this large bulb diminished considerably the deposit of carbon upon the interior of the glass, and therefore the rapid falling off of candle-power with age of the lamp. He had found such lamps very suitable for photometric purposes. His method of employing them was equivalent to the well known system of double weighing. One of these standard lamps was balanced in the photometric gallery by an ordinary incandescent lamp, and then the standard lamp was removed and the lamp the candle-power of which it was desired to determine was substituted for it, and moved in or out towards the photometer disc until it also balanced the ordinary incandescent lamp previously used against the standard lamp. The second of the two papers was by Mr. Clifford Paterson, and was entiled "Some Investigations on the Ten Candle-power Harcourt Pentane Lamp made at the National Physical Laboratory." The author has been carrying out an investigation at the National Physical Laboratory on the effect of changes in the barometric pressure and of moisture in the atmosphere on the flame standard, and the work is still going on.

On Tuesday, August 23, the first business was the reading of the report of the Committee on the Mersey Tidal Regime. Briefly the committee has found that though extensive dredging has now been carried on in the Mersey for such a long period of time, the regime of the tides has hardly been altered.

Major Sir Hanbury Brown then read a most interesting communication on the control of the Nile, the paper being fully illustrated with lantern slides. The author described the whole of the engineering works which have been constructed for the purpose of increasing the area of irrigation in Egypt since the days of Arabi Pasha's abortive revolution. Two great schemes have now been completed, first, the reconstruction of the old delta barrage so that it now can be completely utilised for its original purpose and a head of 20 feet of water can be held up, and, secondly, the construction of the great Assuan dam and Assiut barrage. The wonderful increase in the industrial prosperity of Egypt which has been brought about by these great engineering works reads almost like a fairy-tale, and not the least important of the social advantages has been the abolition of forced labour or corvée. In the discussion, Sir Colin Scott-Moncrieff, who has been responsible for so much of this splendid work, told an amusing story of how, during the reconstruction of the great delta barrage, the last hole, which had almost baffled the engineer, was at length closed by the use of costly curtains taken from an unused Khedivial palace standing near the barrage.

Mr. J. H. Wicksteed's paper on a universal testing machine of 300 tons for full sized members of structures described the machine made for the French Government by his firm, Messrs. Buckton and Co., of Leeds, which was officially inaugurated at the Conservatoire Nationale des Arts et Métiers on June 16 of this year. This formidable machine will take in columns or tension bars 88 feet long by 3 feet 3 inches by 3 feet 3 inches, and it will admit beams 3 feet 3 inches broad by 6 feet 6 inches deep on a 20 feet span, and can be changed from one form of test to another with great rapidity. On the day of the inauguration, a steel tension bar was broken under a load of 228 tons, and immediately afterwards a thick slab of armoured concrete was broken on a span of 16 feet 6 inches.

Prof. J. O. Arnold then read a paper on the fracture of structural steel under alternating stresses, in which he described a method he had devised and the special machine he had invented for placing test specimens under severe alternating stresses slightly beyond the elastic limit; his method, as it were, carried out the Wöhler tests in two or three minutes. Though the investigation was still going on, the author stated that the results obtained so far convinced him that the micrographic methods of examining steel had in their turn failed to show the cause and prevention of sudden rupture under vibration and alternation of stress.

The last two papers on August 23 were contributed by Mr. R. A. Hadfield. The first was on the production of magnetic alloys from non-magnetic metals. In it he stated that Dr. Heusler had produced a magnetic alloy of copper, aluminium, and manganese, and that the magnetic properties of this alloy were to be attributed entirely to the presence of the manganese. Mr. Hadfield himself had made the alloy, and was still carrying on an investigation in reference to it. The alloy was very brittle, and could not be forged either cold or hot. The second paper, on experiments relating to the effect upon the mechanical properties of iron and alloys of iron produced at liquid air temperatures, gave a brief account of some interesting experiments on the effect upon pure iron of great cold. Much fuller details of this investigation are to be given at the forthcoming meeting of the Iron and Steel Institute.

On Wednesday, August 24, the last day of the meeting, several papers of interest were taken, the first being a paper by Mr. Horace Darwin and Mr. C. V. Burton on side-slip in motor cars. The results which had been obtained by the authors in their investigations into this question were illustrated by a small model car, which ran down an inclined plane. The authors were of opinion from these experiments that side-slip would be considerably reduced by steering with the hind wheels and driving with the front wheels, though this car would not be so convenient for steering as the ordinary car.

Prof. Ernest Wilson gave a further account of his experiments on the electrical conductivity of certain aluminium alloys as affected by exposure to London atmosphere. The author has recently been employing micrographic methods in his investigations. He was of opinion that the great difference which existed between the tensile strengths and the other qualities of these alloys was not due to variation in structure.

Mr. J. Casey then described the proposed barrage of the River Thames, and two brief papers, one on the testing of alternating current motors by continuous current, by Mr. Wm. Cramp, and the other on the action of lightning strokes on buildings, by Mr. Killingworth Hedges, brought the proceedings of this section to a close.

It is pleasant to record that the attendance at Section G at Cambridge was considerably above the average, and this was all the more gratifying inasmuch as several of the papers contributed were of unusual importance and of high scientific value.

T. H. B.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE president, Prof. C. S. Sherrington, F.R.S., delivered an address on the morning of August 18, choosing for his subject the "Correlation of Reflexes and the Principle of the Common Path." This address has already appeared in NATURE (September 8).

Prof. J. A. MacWilliam read a paper on reflex and direct muscular response to galvanic currents in fishes. His experiments had proved that eels were remarkably responsive to electrical currents, a responsive fin movement of a reflex nature being readily elicited. The negative pole was usually the effective one. Frogs, newts, carp, &c., gave negative results. After death of the spinal cord much stronger

currents were necessary to evoke any movement, and these were of a different character, being direct responses of the muscles.

Prof. W. H. Thompson read a paper on the metabolism of arginine. If arginine, an important crystalline base obtained by the cleavage of proteids, is administered to animals either by injection or with the food, from 80 per cent. to 90 per cent. of its nitrogen is excreted as urea. In the laboratory only 50 per cent. of the nitrogen can be split off from arginine as urea, the remainder appearing as ornithin. Hence in the body the ornithin nitrogen is also converted into urea, largely or entirely.

Prof. A. Kossel (Heidelberg), referring to the structural formula of arginine, pointed out how half of its nitrogen could be split off as urea by a simple hydrolysis, while the remaining moiety required oxidation before it could be obtained in this form. Dakin and he had shown recently that the liver and some other tissues produced a ferment capable of effecting this hydrolysis. Moreover, they had also found another ferment which possessed the power of acting upon this base in an exactly similar manner while it was still combined within the molecule of certain of the simple proteids (the protamines). The significance of these facts is of great importance in view of the wide distribution of arginine throughout the cell proteids of the body.

Dr. F. G. Hopkins stated that he had some time previously himself taken by the mouth a mixture of the hexone bases, and subsequently watched the hourly elimination of urea. He found that the rate of excretion of urea showed two maxima, the first of which he had ascribed to that part of the N of these bodies which could be obtained in the laboratory as urea, and the second maximum to the remaining N (ornithin, &c.).

Prof. E. H. Starling read a paper on the relation of trypsinogen to trypsin. Pawlow and his pupils have shown that fresh pancreatic juice, obtained from a pancreatic fistula, possesses no power of digesting proteids, but that after it has been acted upon by intestinal juice it gains that power. He concluded that the intestinal juice contained a ferment (enterokinase) which acted upon the trypsinogen of the fresh pancreatic juice, converting it into trypsin. Against this view French observers have brought forward another, viz. that the interaction of the two secretions is analogous to that of the cytases, and that the trypsinogen can only act upon proteids in the presence of enterokinase. Bayliss and Starling have studied the action of enterokinase upon trypsinogen, and by observing the rate of its action have, by finding that it follows the usual laws of ferment action, brought strong evidence to prove that Pawlow's view is the correct one, and that enterokinase is a "ferment of ferments." They have now further evidence in the same direction. By injecting rabbits with solutions of enterokinase, they found that an antibody could be produced which, acting upon enterokinase, was able to inhibit its action upon trypsinogen. Although this in itself could not be regarded as definite proof because the facts might bear another interpretation, yet taken in conjunction with the former evidence it was confirmatory of their view.

Dr. F. A. Grünbaum pointed out that the last evidence brought forward by Prof. Starling did not disprove the view that enterokinase and trypsinogen acted in a complementary manner to one another, since the result might be readily explained on the assumption that the antibody possessed a relatively greater attraction to the enterokinase than to trypsinogen.

Dr. W. E. Dixon communicated the results of his experiments upon the action of alcohol upon the heart and circulation. He pointed out that much of the literature upon the subject was valueless because the experiments had been conducted upon animals already under the influence of anæsthetics. The previous administration of chloroform or ether entirely abolished the first effects of alcohol. The experiments must therefore be conducted upon unanæsthetised animals or upon surviving organs. He proved that the first effect of alcohol upon the pulse was a slight acceleration, which he thought was due to an irritative effect of peripheral origin. The first action upon the heart was distinctly a stimulating one, as proved by cardiometer experiments. The effect upon the peripheral blood-vessels was a dilatation of the limb vessels associated with a constriction of the vessels of the splanchnic area. The effect upon the blood-pressure was a preliminary rise which was only converted into a fall when considerable doses had been given. If larger doses were suddenly administered the effect upon the heart was usually marked inhibition, which he ascribed to a direct action of the drug upon the cardiac centre.

Prof. E. A. Schäfer remarked that in some recent experiments he had found that if a mixture of chloroform and alcohol was made to replace the chloroform with which the animal was being anæsthetised, the result was an acceleration of the heart-beat, together with an increase in its force. This was not due merely to the diminution in the amount of chloroform administered.

The morning of August 19 was devoted to a discussion upon the relation of oxidation to functional activity. A report of this discussion appears in another part of NATURE (p. 590). Mr. Hankin's remarks on the spread of plague will be printed separately in another issue.

Dr. W. H. R. Rivers communicated the results of some of his observations on the senses of the Todas. These were made by methods similar to those which had been employed in the work of the Cambridge Anthropological Expedition to the Torres Straits, and the results were in general confirmatory of those reached by that expedition. The observations on Papuan and Toda seem to show that there is no marked difference between uncivilised and civilised races in purely sensory powers. Any superiority in the sensory and perceptual feats of the savage is probably due to his powers of observation and of drawing inferences based on his familiarity with his surroundings. Where there are differences between Papuan, Toda, and European, the Toda occupies in general an intermediate position between the Papuan and European, just as he occupies an intermediate position between them in intellectual and cultural development.

The only striking feature which marks off the Toda from the others is the great frequency of colour-blindness. Whereas this condition is absent or very rare in some savage races, the proportion of colour-blind persons amounts to 12·8 per cent. in Toda males as compared with about 4 per cent. in European races.

Dr. C. S. Myers communicated a paper upon recent developments in Helmholtz's theory of hearing. He alluded in the first place to Ebbinghaus's conception of an internodal vibration of the basilar fibres, and showed its value in providing a theoretical basis for the degree of relationship between the various musical intervals. Next he referred to the discovery of intertones (Zwischentöne) by Stumpf, and to their importance in determining the number of adjacent basilar fibres thrown into vibration by any simple tone, and in modifying the principle of specific nervous energy as applied to the ear. Schäfer's theory of the origin of subjective combination-tones was then described, and the difference between objective and subjective combination-tones was discussed. Lastly, Dr. Myers showed the great value of Helmholtz's theory in best explaining the known pathological phenomena of hearing, and suggested that the hair-cells rather than the basilar fibres might be the sympathetically vibrating end-organs. Such a modification involved the application of altered physical considerations to the organ of Corti, but appeared more rational and less difficult on the whole.

In the morning of Monday, August 22, the work of the section was devoted to a discussion on conduction and structure in the nerve-arc and nerve cell.

Prof. J. N. Langley, in opening this discussion, said that he restricted himself to a consideration of the general scheme of structure and arrangement of the nervous system in vertebrates, and the broad relation of this scheme to nervous functions. At present there are two main ideas of structure, one often called the neurone theory, according to which the nervous system is made up of a multitude of neurones or cells which have no connection with one another, and the fibrillar theory, according to which the nervous conducting part consists of minute fibrils joined together here and there into a network. Prof. Langley argued that whatever view is taken of the structure of the nervous system, the facts of degeneration of nerves show that it is made up of a number of trophic units, and that the theory of trophic units held whether the unit consisted of one or

of a hundred cells, and whether the units were in continuity with one another or only in contiguity.

A second point which seemed certain was that the properties of the central nervous system required for their explanation some structure not present in the peripheral nerves. This structure might be, in part, the nerve-endings of the trophic units, but, in part, it must be referred to the nerve-cells, which, in fact, consisted of different protoplasm from that of either nerve fibres or nerve-endings.

If the fibrillar theory were true, there were facts which showed that the fibrils must be different in different parts of their course. This was illustrated by the action of nicotine and of other poisons on the different parts of the nervous system. With this modification, the fibrillar theory simply transferred to a part of the cell functions which were commonly supposed to belong to the whole. But it could not be regarded as certain that there were any fibrils at all in the nerve cell, for the microscopic appearances varied considerably according to the method of preparation.

A point which was much contested was the question whether the trophic units were continuous with one another or not. This point was not of great physiological importance, but the physiological facts were best explained on the assumption that the units were contiguous but not continuous.

The last point considered was whether the unit consisted of a single cell or of many cells. The study of the development of nerves had led different observers to entirely opposite conclusions. Experimentally, the question was of interest in connection with the regeneration of nerves. Numerous surgeons had found new nerve fibres in the peripheral ends of cut nerves, but their observations failed to show that some central connection had not been established. In some recent experiments made by Prof. Langley in conjunction with Dr. Anderson, it was found that without a single exception, the new fibres had become connected with the central nervous system. The balance of evidence was then against the occurrence of autogenic regeneration and in favour of the unit consisting of a single cell.

Dr. A. Hill stated that he was entirely prepared to give his approval to the neurone theory as defined by Prof. Langley, but he objected that this was merely a statement of the cell theory and did not require the special title given to it by Waldeyer. He was inclined to think that the more light we gained on this subject the more should we find that Bethe's view was correct. Apathy has shown a network of neuro-fibrillæ in nerve cells of invertebrates. This network is easily shown, and is beyond all doubt a structure existing during life. In the spinal ganglion cells of vertebrates a somewhat similar appearance is obtainable. It was easy to make preparations of vertebrate nerve cells in which fibrillæ were indisputably present, but how far this appearance was due to reagents it was impossible to say; but there was a strong probability that the net arranged itself about an existing system of fibrils. The connecting link appeared to him to be the "thorns," and it was a remarkable fact that the spacing of the thorns corresponded to the spacing of the pericellular network. Far as we were from being in a position to form a conclusion on this subject, it was not impossible that neuro-fibrillæ, Golgi's net, and thorns form a system of conducting fibrils of extreme tenuity and almost infinite complexity.

Prof. Graham Kerr gave an account of the results of his researches on the development of the nerves in Lepidosiren. His first studies on the mode of growth of the nerves in these animals seemed all in favour of His's view that the nerves developed as outgrowths from the spinal system, but more extended observations upon embryos in various stages of development led him to the conclusion that the fibres originated as strands of undifferentiated protoplasm extending between the neuroblasts of the spinal cord on the one hand and the developing myotonic cells on the other. At a somewhat later stage fibrillæ appeared in these strands, and still later a sheath was formed from mesoblastic tissue which surrounded and enclosed the group of fibrillæ. A more doubtful conclusion which might perhaps be drawn was that the original path was one along which impulses surged to and fro, and that consequent upon this use the fibrillary structure was developed as a more convenient substratum for the maintenance and extension of that function.

Dr. Mann pointed out that nerve cells might be theoretically in one of three states, viz. separate units, or continuous with one another, or at one time continuous and at another separate. In all embryos at a certain period the motor cells in the cord form a syncytium with scattered nuclei, an arrangement which later on becomes less and less marked until in most cases the cells form separate units. Cells not derived from a common mother cell are never in continuity. He pointed out that great care was needed in drawing conclusions from any preparations where such electrolytes as corrosive sublimate were used for purposes of fixation, inasmuch as all coagulation by electrolytes invariably leads to a very distinct fibrillar appearance. This is much less marked after the use of such non-electrolytes as osmium tetroxide or formaldehyde free from formic acid. At present, therefore, we are not in a position to make any assertions as to the existence or non-existence of fibrils in nerve cells or in tissues.

Dr. W. B. Hardy also directed attention to the treacherous nature of the evidence of fibres and networks in cells. A fibrillar structure can be produced from a perfectly homogeneous solution of egg-white by fixing it with the ordinary reagents and staining it in the usual way. Again, if a concentrated viscous solution of egg-white be stretched between two points and then treated with the ordinary fixing reagents, it can be shown that the fibrils produced in it run longitudinally, and are connected by less prominent ones which run transversely. These fibrils must, of course, be purely artificial.

Dr. H. K. Anderson emphasised the point that though the neurones might be physically continuous, yet on the whole they must be trophically discontinuous. Experimenting upon very young animals, he had found that section of a post-ganglionic segment led to degenerative changes in the corresponding preganglionic segment. On the other hand, the converse was not true. As a further point against the view that the fibrillæ of a preganglionic segment were continued down into the postganglionic fibres, he pointed out that Langley had shown that the mode of termination of the preganglionic fibres in the sympathetic ganglia was not specific, since an ordinary motor nerve can be made to grow down to a sympathetic ganglion, and terminating there in its own specific manner could yet establish physiological continuity.

Dr. E. Overton pointed out that it had been proved that the presence of sodium ions was an essential condition for the physiological activity of both muscular and nervous tissues, and, in the second place, it had been shown that both sodium and calcium ions were essential for the proper action of nervous interconnections, thus tending to prove that some third substance intervened between the two units, *i.e.* that there was discontinuity.

Dr. W. MacDougall argued that the fact that motor neurones could not conduct backwards was the best evidence of discontinuity. Upon the same hypothesis depended also the simplest explanation of another typical characteristic of nervous activity—the effect of summation of weak stimuli. Moreover, the "law of nerve habit" was most difficult to explain except on the assumption that there is some intermediate structure between successive nerve elements which offers a resistance to the transmission of impulses, a block, however, which can be overcome by the action of appropriate stimuli.

Prof. Langley, in replying on the whole discussion, suggested among other points that the strands of material described by Dr. Kerr in the development of nerve fibres might be simply connecting structures along which the nerve fibrillæ, *i.e.* the true nerve element, grew down from the developing neuroblast.

Prof. E. A. Schäfer demonstrated a method of artificial respiration which is a modification of one first suggested by Dr. B. Howard in 1869. In Howard's method the patient in a case of drowning is first turned downwards and the back is pressed on two or three times to force out water from the lungs, after which he is turned face upwards. The operator is then directed to grasp the lower part of the chest and to press gradually forward with all his weight for three seconds, then with a push to jerk himself back and wait three seconds, repeating this eight to ten times a minute.

This method is simple, can be performed by one person,

and is fairly efficient so far as air exchange is concerned. The drawbacks are that the tongue in the face-up position tends to fall back and block the passage of air through the pharynx; that there is risk of rupturing the liver; and that there is risk of breaking the ribs if the operator is heavy and powerful and if the patient is advanced in years.

These drawbacks are avoided if the patient be turned into the prone position during the whole procedure. Greater efficiency is thereby attained, and the risk of injury to ribs or viscera is reduced to a minimum. The muscular exertion required is only that needed to swing the upper part of the body backwards and forwards on the hands about twelve or thirteen times a minute, the operator kneeling by the side of or across the patient. The pressure is gradually applied and gradually released. The amount of air exchanged by this method per minute is greater than that yielded by any other which has been tried, and may even exceed the ordinary rate of exchange of the individual.

Tables showing the amount of air exchanged in the various methods which have been recommended for artificial respiration were shown, from which it was seen that only in Howard's method and in Schäfer's modification of that method did the amount reach that attained in normal respiration. Schäfer's method is easy to carry out, even for prolonged periods, and is sufficient for the needs of a normal individual who submits himself to be respired in this manner. On the other hand, in both the Sylvester and Marshall Ward methods, a normal individual is unable to refrain from himself actively respiring on account of the air-exchange being insufficient.

Dr. F. W. Edridge-Green read a paper on the necessity of a lantern test as the official test for colour blindness. Dr. Edridge-Green described two cases, both naval lieutenants, which he had examined, in both of which the men passed the wool test but failed when examined by the lantern test. These were selected because both had daily experience with coloured lights and not with wools. He concluded, then, that because a man can sort wools correctly it does not follow that he can distinguish between coloured lights. In his opinion many varieties of colour blindness may escape detection by the wool test.

On Tuesday, August 23, Prof. A. Kossel (Heidelberg) communicated the main results obtained in work conducted in conjunction with Mr. H. D. Dakin on the protamines. These are the simplest type of proteids. One of them, salmin, when treated with boiling dilute mineral acid yields only five atomic groupings, viz. urea, diamido-valerianic acid, serine, monoamido-valerianic acid, and pyrollidincarboxylic acid. They had investigated the relative proportions in which these five substances were present in salmin, and had found them approximately as follows:—ten molecules of diamido-valerianic acid, ten of urea, two of serine, one molecule of monoamido-valerianic acid, and two molecules of pyrollidincarboxylic acid. The composition of clupein was found to be complicated by the presence of alanine in addition. On the other hand, scrombine possesses an even simpler constitution, for, in addition to urea and diamido-valerianic acid, only alanine and pyrollidincarboxylic acid were found. Sturin obtained from the testes of the sturgeon presents a different constitution. Two diamido-acids are present, diamido-valerianic acid and diamido-caproic acid, the former being combined with urea. To this complex a heterocyclic group, histidine, remains to be added.

The ordinary proteids differ mainly from the protamines in an increased proportion of monoamido-acids, so that the complexity of molecule is extraordinarily great. This complexity is further increased by the addition of other groups, e.g. dibasic acids such as aspartic and glutamic acids, which are not present in the protamines.

Prof. J. E. Johansson (Stockholm) gave an account of his experiments upon the immediate effect of carbohydrates upon metabolism. These experiments dealt with the rate of excretion of carbonic acid following the administration of various carbohydrates, and were conducted upon man in a respiration chamber. He first showed that for a particular individual the rate of excretion was practically constant if taken some hours after a meal, and that this rate did not vary with differences in the previous diet nor at different periods of the year. If, then, an individual is given a quantity of a particular carbohydrate about eight hours after a meal, the amount of increase in CO_2 excreted is to be assigned to the food given. He showed in this way that an increase of CO_2 followed the administration of glucose, saccharose, or levulose, and that this increase, which amounted on the whole to from 8 per cent. to 20 per cent. of the total carbon given, began within the first half hour and lasted from two to three hours. The increase persisted longer after saccharose or levulose than after dextrose, and the total amount was greater. He further showed that the amount of the CO_2 surplus was in proportion to the amount of carbohydrate given if this did not exceed 150 grams. The effect of a dose of sugar was greatly influenced by the previous state of nutrition of the person experimented upon. Thus, after a fasting period of forty hours, the amount of carbon retained was much greater than after a ten hours' period. A further point of interest was that the amount and rate of destruction of the various sugars were not influenced by the performance of work. The two effects were additive, and did not interfere with one another.

Mr. P. P. Laidlaw gave the results of some observations on blood pigments. The iron in hæmochromogen is unstable to dilute acids a fact which shows that hæmatoporphyrin is present in the hæmatin molecule. This was absolutely proved by the artificial formation of hæmochromogen by warming iron free hæmatoporphyrin in an ammoniacal solution to which Stokes's fluid was added from time to time, when on repeatedly reducing the mixture for an hour or so hæmochromogen was formed. The method of synthesis renders it probable that hæmatin is a combination of two hæmatoporphyrin groups with one of iron. Turacin also may be synthesised from hæmatoporphyrin by boiling with cuprammonium solutions.

Dr. F. G. Hopkins wished to lay stress on a further point which had not, perhaps, been brought out very clearly in Mr. Laidlaw's paper. It had been found that if reduced hæmoglobin was treated with a mineral acid, the decomposition went as far as the production of hæmatoporphyrin, whereas, when the same hæmoglobin was converted into oxyhæmoglobin and then treated with acid, hæmatin only was produced. From this it was clear that a very fundamental part was played by the iron in the conversion of hæmoglobin into oxyhæmoglobin.

Prof. A. B. Macallum (Toronto) read a paper on the distribution of potassium in animal and vegetable cells. A solution of the double nitrite of sodium and cobalt gives a yellow precipitate with a potassium salt. If, therefore, thin pieces of the tissue to be examined be treated with this solution, and the excess of the reagent be washed away with ice-cold water, the position of the potassium in the cells is indicated by the presence of the yellow precipitate. Its localisation may be rendered more obvious by converting the yellow precipitate into a black one by further treatment with ammonium sulphide, which precipitates the cobalt as a black sulphide. In this way is was found that potassium is never diffused through the cell. It is more abundant in vegetable than in animal protoplasm, and the nucleus is always absolutely free from it. Only one tissue element was found absolutely free from it, viz. the nerve cell and the axis cylinder. All dead and inert material in a living tissue becomes charged with potassium. This is especially the case with intercellular material.

Dr. W. B. Hardy remarked on the difficulties of determining the distribution of a soluble substance in so small a structure as a cell, for diffusion may be relatively rapid, and thus the results obtained might be very misleading.

Prof. Brodie suggested that the reason why the nucleus never contained any of the precipitate could be readily explained on the assumption that the nuclear membrane was impermeable to the cobalt salt. This, too, would explain the fact pointed out by Prof. Macallum that in many instances the precipitate was found accumulated immediately around the nucleus, for if the nuclear membrane were impermeable to the cobalt salt but permeable to a potassium salt, the latter as it diffused out would be precipitated at once by the excess of cobalt salt present in the surrounding protoplasm.

Prof. W. O. Atwater described his investigations on the nutrition of man at a joint meeting with the section of economics. An abstract of the paper will appear in another issue of NATURE.

Dr. W. Page May brought forward a communication by Prof. Elliot Smith and himself on the motor localisation in the lemur. He showed the area stimulation of which produced movements on the opposite side of the body, and demonstrated that the sequence of representation of movement was in agreement with that of Sherrington and Grünbaum on the ape. It also cleared up the discussion on the homologies of a small sulcus which had previously been described as postcentral and precentral, but which is really central, as Elliot Smith, arguing merely from morphology, pointed out two years ago.

He also described the results of localisation in the dog obtained by Elliot Smith and Wilson, who have shown that the excitable area is limited anteriorly by the crucial sulcus. This result was in harmony with the histological results of Cushing.

In a second communication Dr. Page May discussed the results of previous workers on the optic thalamus, and described some experiments he had made on this subject. He showed that following lesions in the thalamus certain motor disturbances were produced, and that descending paths could be traced from the thalamus into the anterior and lateral columns of the spinal cord. He also showed photographs and specimens of a descending tract hitherto undescribed in the posterior columns of the cervical and dorsal cord. This extended downwards from the thalamic region, and occupied a position near the middle line at the anterior end of Goll's column. In rare cases fibres could be traced into the lowest portions of the spinal cord.

Prof. G. S. Woodhead communicated the results of an investigation on joint-ill in the foal. This is an affection of especial importance to horse-breeders, in which, in addition to certain constitutional symptoms, marked stiffness and swelling makes its appearance in the joints, while at a later stage abscesses form. Investigation of the cause of this disease proved it to be due to a microorganism which gained admittance into the young animal through the cut end of the umbilical cord. From the practical point of view it was therefore evident that such precautions as are taken against septic infection in the case of the child at birth should also be taken in the case of the foal.

Dr. T. S. P. Strangeways gave an account of a committee of pathological research which is being founded with the object of investigating some of the more important diseases the pathology of which is as yet undetermined. The proposed lines on which the committee intends to act is to select some special disease and make an exhaustive study of it from all sides, a study which will last for two to three years. It is proposed to found a small hospital which shall be devoted entirely to cases of that disease during its period of study. The committee is to be a comprehensive one, and include all who will watch the course of the disease or who will undertake research work on the subject. These will report to a central body, which will also be responsible for the distribution of the collected facts and literature of the subject to those actively engaged in working upon it.

Prof. C. S. Sherrington and Miss S. C. M. Sowton communicated the results of an investigation into the amount of chloroform which, when administered to the heart, can dangerously embarrass its action. For this inquiry they had adopted the method, gradually evolved of recent years, of keeping the excised heart of a mammal alive by perfusing its blood-vessels with warm nutrient solutions. The heart used by them was that of the cat. The beating of auricle and ventricle was recorded graphically. The effect of chloroform was examined by allowing the perfusing fluid, pure saline, serum, or blood, as the case might be, to be replaced by a similar fluid to which chloroform in known quantity had been added. When this was done the chloroform showed its effect, practically at once, by diminishing the amplitude of the beat without altering its rate. The amount of the diminution was proportionate, within limits, to the concentration of the solution of chloroform. When exhibited in saline solution, chloroform showed a depressant action even in a dilution of 1 part in 150,000 of the saline solution. The full amount of the depression caused by a given solution was rapidly reached, *e.g.* in a minute, and then the continued administration of that solution caused no further depression—even if continued for half an hour at a time. That is to say, there is no cumulative action of the drug detectable in the isolated heart so perfused for a period of half an hour. On the contrary, there was generally evidence of a slight waning of the depression as the exhibition of the drug was uninterruptedly maintained. This tolerance was, however, quite evanescent, for on interrupting the perfusion with the chloroform solution and then returning to it, the depression recurred in its original depth. On discontinuing the perfusion with chloroform solution and reverting to the chloroform-free fluid, the depression caused by the chloroform—unless the chloroform solution has been of great concentration—is extremely rapidly removed, even when the beat of the heart has been for many minutes practically abolished. This suggests the view that the effect of chloroform on the cardiac muscle is due to the formation of some easily dissociable compound between the chloroform and some active constituent of the tissue. It has been recently urged by Moore and Roaf that this constituent is a proteid, and in favour of this view is a further fact elicited in the present inquiry. On comparing the amount of depression of a chloroform solution of given concentration, in salt solution on the one hand and in blood on the other, it is found that the effect of that concentration in blood is much less than it is in salt solution. In other words, the effect of a chloroform solution of given concentration in blood is only equivalent to that of a solution barely one-twelfth as concentrated in salt solution. This can be explained by supposing that the salt solution, though it supports the beat of the heart, supports it less well than does blood; but the more important part of the explanation seems to be that the tension of the chloroform in the blood is much less than in the salt solution. In other words, the difference seems referable to some constituent of the blood taking up and holding, in a relatively inactive form, a considerable fraction of the chloroform added to it. The chloroform added distributes itself in that complex fluid according to a coefficient of partition. It is only what is left over freely dissolved in it which is available for acting on the heart tissue. Comparative estimations of the depressant effect in blood, serum, and saline solution show that serum is intermediate between the other two, so that evidently the corpuscles contain, in large measure, a substance that combines with the chloroform.

THE RELATION OF OXIDATION TO FUNCTIONAL ACTIVITY.[1]

In opening this discussion, Sir John Burdon-Sanderson said:—

In undertaking to open this discussion, I do not claim to contribute any results of my own researches or to speak on any subject *ex cathedra*, or with any degree of finality. I propose to state very shortly what seem to me the discussable questions, *i.e.* those respecting which we have experimental data, and to submit to the section those on which we need enlightenment.

The title is "Oxidation and Functional Activity." May I say that, without criticising it, I would ask for some latitude as regards the word oxidation. By oxidation is meant the formation of an oxide. Now we know that in the living organism oxygen may and does act without this happening, *e.g.* in those processes of which the oxygenating of the colouring matter of the blood is the type.

This is so important a distinction that I would suggest to substitute in these cases the term "oxygenation." The subject of our discussion would then be rightly stated as follows:—"The Relation between Oxygen and the Chemical Processes which Constitute Animal and Plant Life." The older notion of the part played by oxygen in the chemical processes of life was that it was a destroyer and not a maintainer of the chemical energies of the cell. We now recognise that oxygen may have a double function to perform, first as an element the presence of which is essential to the anabolic process by which living matter is built up, and secondly as equally essential to the disintegrative process which, taking muscular activity as the type of others, is associated with the performance of function. Of these two actions, in each of which oxygen is concerned the *con*structive and the *de*structive—the second is better under-

[1] Report of a discussion before the Section of Physiology at the Cambridge meeting of the British Association, August 19.

stood than the first. It can be proved experimentally that in the living organism muscular work is accomplished by the transformation of a corresponding amount of chemical energy, however imperfectly we may understand how this transformation can occur at the temperature of the body. But as regards the participation of oxygen in the process of *restitution*, we are obliged to frame for ourselves a hypothesis and to clothe it in chemical language, according to which each elementary function is represented by a specific kind of living matter, *i.e.* by an aggregate of *living molecules* each of which is endowed in equal degree with the capacity of discharging the function which it represents. The difficulty lies in this, that the physiologist finds himself compelled to use chemical language in a sense which the chemist does not recognise. What we mean thereby is that the hypothetical living molecule consists of a permanent part which is not concerned in the performance of function, and of a collateral part which is used, *i.e.* disintegrated in every transition of the molecule from the inactive to the active state, to be immediately re-constituted when action ceases. This notion of *restitution* is the nutshell in which the difficulty lies. All that we know about it is that the access of oxygen is an essential condition for its accomplishment—oxygen not as an oxidiser, but as a restorer of functional capacity.

I now propose to pass from the general to the particular, *i.e.* to the consideration of the chemical process of life as it presents itself in particular organs, namely, first in muscle and in nerve centre, and secondly in such glands as have up to this time been investigated—two groups of structures representing what Bichat called respectively animal life and organic life. On the general principle that in all our investigations we should proceed from the known to the unknown, muscle must be taken first, for its metabolism is more within reach of investigation and is better understood than that of any other organ.

When oxygen enters the living substance of muscle it is not as an oxidiser, but as a preparer and builder up of material ready for explosion. For the muscle molecule receives two things from the blood, oxygen and oxidisable material, but these two do not combine as a mere result of juxtaposition or of encountering one another. As Ostwald says, "Der freie Sauerstoff ist ein sehr träger Stoff," at the temperature of the body. It cannot be brought into action in the living organism by a stimulus so long as it is in its free state. It must first become what Pflüger calls "intramolecular," and thereby change its Trägheit for mobility. The immediate effect of the access of oxygen is that the living substance of which it becomes a part becomes more susceptible to mechanical and electrical disturbance, *i.e.* more excitable than it was before. It requires, so to speak, to be wound up so as to become capable of discharging its oxidising function when awakened by a stimulus. Dr. Fletcher's experiments, to which I will return later, show that the more perfect this preliminary anabolic process is the more complete will be the catalysis.

You will, I think, agree with me that in different stages of the metabolic process which is associated with muscular function oxygen acts in different ways, at one time taking part in an integrating process for which we might, perhaps, employ the word oxygenation, at another in a process of oxidation, the molecule in which this occurs retaining its existence notwithstanding the disintegration of its oxidisable part.

We have now to pass on to the question how oxygen takes part in the functional activity of the central nervous system. The only part of that system which is within reach of experimental investigation is the spinal cord. We have to consider in how far the results of investigations in the cord and in muscle agree or differ

Let me say on the threshold that our knowledge is largely due to work recently done at Jena and Göttingen under the direction of (or in cooperation with) Prof. Verworn. I must first ask your attention to the method.

More than thirty years ago Cohnheim taught us the use of a preparation which we used to call "the salt frog," in which the blood was replaced by physiological salt solution. He discovered that notwithstanding the defect of hæmoglobin, and consequently of oxygen, the chief functions of life could be carried on. With much more perfect methods Verworn has followed Cohnheim. The improvement consists in this, that the circulation is maintained by mechanical means, so that by varying the rate of flow and the percentage of oxygen in the liquid the supply of oxygen to the cord can be increased or diminished at will. The effect produced is judged by the mechanical responses to reflex excitation, the indications given by which are rendered more delicate by the previous administration of a trace of strychnine. The first step in the experiment is to establish a normal state of things by the circulation of salt solution which has been freely exposed to air or oxygen. Under these conditions the response to stimulation of the surface consists of a succession of brief tetani, each lasting two or three hundredths of a second. The next step is to substitute salt solution which has been deprived of oxygen, and to observe that the reflex centre is gradually paralysed, as indicated by the fact that single tetani have taken the place of the serial responses, that on renewing the supply of oxygen the former state of things is restored, and, finally, that these changes may be repeated over and over again with the same result.

All these facts come under the general statement that while oxygen has no power of acting as a stimulus it increases the excitability of the centre, enabling it when excited to discharge itself so completely that after the discharge it is wholly incapable of responding. It further shows that oxygen shortens the time required for restitution to the normal—reintegration following disintegration—anabolism following katabolism so immediately that they may almost be considered as simultaneous.

If we compare the behaviour of oxygen in the centre with its behaviour in the muscle, we shall find that they differ chiefly in one particular, namely, in their time-relations. In both cases oxygen acts as a predisposing, not as an exciting cause of functional activity. In both cases a *tertium quid* is wanted—a liberating or letting off mechanism; but in the muscle the functional cycle is accomplished in scarcely more than 1/100 sec., whereas in the centre the effect occupies a few hundredths of a second, and the preparation for it a much longer period. There is therefore no difficulty in understanding why the so-called refractory period can be so easily observed and measured in the centre (while in the muscle its presence can only be inferred), a circumstance which is helpful as affording an additional evidence of the anabolic action of oxygen; for it is easy to show that the period in question is shortened by supply of oxygen, protracted by its absence.

We now come to the last point which I am anxious to submit to you—that of the relation of oxygen to the function of glands. I must begin by saying that it is in this part of our subject that the crux lies, for the investigation of the intimate metabolism of glands is beset with difficulties even greater than those of muscle and spinal cord.

Mr. Barcroft, to whose admirable researches we shall have occasion to refer repeatedly to-day, found as the result of his estimate of the oxygen and carbonic acid yielded by the blood circulating through the submaxillary gland under different conditions that this gland takes from the blood much more oxygen when excited by the chorda tympani than when at rest, no such effect occurring when the excitation had been rendered ineffectual by the previous administration of atropine. These observations gave good reason for believing that oxygen promotes the action of the cells, but afforded no evidence that this action is attended by a corresponding discharge of carbon dioxide. Similarly Prof. Starling, whose experiments were made with Mr. Barcroft's cooperation, found that when the pancreas is made to act by the injection of secretin a similar want of relation presented itself between the quantity of oxygen taken in and of carbon dioxide discharged. Finally, the comparison which has been recently made by Dr. Brodie (who will, I hope, explain to us his very admirable method) of the state of activity of the kidneys with the state of rest, points to the same conclusion as regards that organ. When diuresis was produced by the injection of urea, the clearest evidence was given of the increased demand for oxygen, the intake of which was very largely increased, but there was no indication that the ultimate products of oxidation found their way into the blood in quantities proportionate to the oxygen supplied.

Taking these data as our point of departure, what can we infer from them as regards the resemblances and differences between the two processes we have been considering,

viz. the functional activity of muscle and nerve centre on the one hand, that of gland on the other? The *obvious* contrasts which exist between secretion, muscular contraction, and reflex innervation need not be dwelt upon; the one thing with which we have to do is the nature of the chemical processes which are associated with these three forms of activity. If analogies are to be sought for it is here they will be found.

I submit to the section, and particularly to those members of it who are engaged in experimental researches on the subject, that the most important contrast between the concomitant chemical processes of gland function and muscle function consists in this, that whereas the former is not in any marked degree katabolic, the dominant process in the oxidation which is inseparably associated with the performance of muscular function *is* katabolic. We can readily account for this by reference to the fact that whereas the processes in muscle and in reflex centre are excitatory, those in glands are for the most part determined by stimuli of a very different kind from those that evoke nervous or muscular action, which last act exclusively as liberators of katabolic processes which are waiting to be discharged.

We have long been accustomed to regard the process by which, in muscle, chemical is translated into mechanical energy as explosive and instantaneous, and to take the end-result—the discharge of carbon dioxide—as the necessary concomitant of the production of heat and work; but as I remarked before, Dr. Fletcher recently published experiments which seem to show that for the attainment of this ultimate result it is essential that the muscle should be abundantly supplied with oxygen, in failure of which the oxidation process may stop short before its completion. I trust that we shall have the advantage of hearing to-day the further results of his researches, and particularly that he will give us information as to the relation between efficiency of contraction and the degree of completeness of the oxidation process.

In conclusion, the questions which present themselves are:—

(1) Whether it may be generally stated that the oxygen which is conveyed to the living matter of the tissues by the blood *is stored as "intramolecular oxygen" until it is required for the performance of katabolic functions*, and, if so, what is the *chemical relation* between the stored oxygen and the living molecules by which it is held? In submitting this question, I must again ask that the use of the term "living molecule" may be condoned.

(2) Whether it may be assumed that every *disintegrative process conditionates a subsequent integrative process* by which the *status quo* is restored in the same living molecule; if so, does the anabolic effect which in muscle *follows* the change of form constitute as much a part of the response to stimulation as the catabolic effect which *precedes* the change of form? Can this be said of the chemical process which is associated with functional activity in gland?

Continuing the discussion, Dr. W. M. Fletcher pointed out that in the muscle cell only the katabolic processes had been effectively studied, and that these are characteristic of the special material giving energy for contraction—a material probably without analogue in the gland cell. The classical conceptions, due to Pflüger and to Hermann, of this material as a highly oxygenated substance breaking down, whether rapidly as in contraction or slowly as in survival periods, by inevitable stages to the ultimate stages of carbonic acid and water, irrespective of a contemporary supply of oxygen, were discussed and compared with the views of Verworn. It was urged that while a preliminary oxygenation of the living molecule may be admitted on wide grounds as the condition of irritability, such a conception by no means precludes the idea of additional oxidative processes occurring at some stage or stages of the katabolic disintegration. Disintegration effected under anaërobic conditions might, on this view, stop short of its normal end-products, these being replaced by representatives of earlier stages in the breakdown. Evidence in this direction has been got from three main classes of experiment. In the case of excised muscle, Dr. Fletcher's observations of the relation of oxygen supply to the yield of carbonic acid in rest and in activity, and to the onset of fatigue and of rigour, were described and held to be incompatible with the view that the entrance of oxygen conditioned the lability of the molecule without further influence upon the subsequent course of katabolism. A second class of evidence was derived from the work of Chauveau and Kauffman, Ludwig and his pupils, Minot and others, upon the respiration of muscles with artificial circulation. An increased yield of carbonic acid due to activity was claimed or denied by these observers strikingly in proportion to the success with which the artificial circulation had been made to reproduce the normal. A third and large body of evidence is supplied by observers like Araki, Geppert, Meyer, and others, who have studied the results of muscular contraction with normal circulation, but under conditions of deficient oxidation. Anaërobic conditions always appear to diminish the amount of carbonic acid expired, while increasing the amount of acid products in the tissues, the blood, or the excreta.

Prof. N. Zuntz (Berlin), in a letter addressed to the section, referred to some of the points which it had been suggested should be dealt with in the discussion, in the following terms:—"Is one justified in drawing a hard and fast line between the anabolic and the katabolic processes on theoretical grounds? Would it not be more correct to take Pflüger's view and regard that process as the normal one in which every katabolically decomposed molecule is at the very moment of decomposition anabolically regenerated by taking up oxygen and oxidisable groups? In this case one would regard the katabolic processes, which render the molecular structure less stable and give rise to free affinities, as the factor which inaugurates and makes possible normal anabolism. In this connection, however, the fact remains that anabolism can also take place later on, if an element such as oxygen, necessary to the building up of the molecule, should be wanting at the time that the katabolic processes occur. It is accordingly a subject for investigation to decide whether subsequent regenerative processes occurring in the above manner take place as easily as normal assimilation occurring at the same time as the breaking down of the molecule, or whether they use up more energy if they occur later. I have already some data which tend to show that anabolism demands more energy if it has to take place at a period after the katabolic processes, but I dare not yet give any definite verdict on the question.

In regard to the question as to how far the metabolic processes may be the work of an oxidase, I should like to lay stress on the fact that the fundamental importance of innervation for katabolic processes in muscle is not easy to reconcile with the assumption that these processes are much affected by ferments. Neither does the great influence which the tension of a muscle has on oxidation processes in it harmonise with our knowledge of the action of enzymes.

Prof. T. G. Brodie described the results obtained in experiments, conducted in conjunction with Mr. Barcroft, upon the gaseous exchanges in the kidneys under the different conditions of rest and activity. In all cases they had found that the amount of oxygen taken in by a kidney which was made to secrete urine actively was greatly in excess of that absorbed by a resting kidney, while on the other hand the quantity of carbonic acid eliminated showed far slighter variations. In the greater number of their experiments they had found that the kidney at rest eliminated a greater volume of carbonic acid than it absorbed of oxygen. Their results thus indicated that the performance of work by the kidney was accompanied by an approximately proportional increase in the intake of oxygen, while the output of carbonic acid, although increased, was usually much less in amount. From the fact that the carbonic acid output was often in excess of the oxygen intake, it would seem that the final metabolic changes, as evidenced by the carbonic acid output, was a more gradual process, though the results they had obtained, up to the present, did not warrant the conclusion that the carbonaceous waste products resulting from the activity of the tissue were confined to carbonic acid only.

Mr. J. Barcroft, in discussing the metabolism of glands generally, pointed out that there were three methods which had been used for the investigation of their gaseous metabolism. In the first, an excised organ was kept in an enclosed space, and the surrounding air analysed. This method had been dealt with by Mr. Fletcher, who had pointed out that the method shed light on the katabolic

phase of activity only. In the second method the general gaseous exchanges of the body were watched during states of rest and activity of the organ to be investigated. This, however, was inapplicable to the glands of the body on account of their small size. The third method was that of measuring the blood gases, combined with an estimation of the rate of flow of blood through the gland.

Three glands have been studied by this method up to the present, the submaxillary, the pancreas, and the kidney. In the submaxillary gland the problem was very complicated, since the blood became concentrated, losing a tenth of its water or even more, and a considerable quantity of the carbonic acid left the gland in the secretion. After due allowance had been made for these disturbing factors, it appeared that the O intake and the CO_2 output were increased from three- to four-fold during stimulation of the chorda tympani nerve. As to how far these changes might be due to concomitant vascular changes was studied by examining the gaseous exchanges of an atropinised gland during stimulation of the chorda. It was found that this led to no increase in the amounts of O withdrawn, though an increased output of CO_2 was observed.

In the pancreas, which had been studied in conjunction with Prof. Starling, there was often no increased flow of blood synchronously with a secretion following an injection of secretin. They invariably found an increased absorption of O. Usually this increase was considerable; thus from eight comparisons the mean quantity of O taken up by the resting gland was 1·5 c.c. per minute, and by the active gland 5·5 c.c. per minute. These results were entirely in harmony with those brought forward by Prof. Brodie for the kidney.

It seemed, then, that glandular activity was accompanied by a large and instantaneous consumption of O, but that it was not necessarily accompanied by an increased CO_2 output.

Another point indicated was the magnitude of the gaseous metabolism of glands. In the submaxillary and in the pancreas, when at rest, about 0·025 c.c. to 0·035 c.c. of O per minute per gram of gland substance was absorbed. In the kidney Prof. Brodie had given one instance in which the organ was using as much as one-fifth of the total quantity of O taken in by the lungs, and it was common to find the O consumption of the kidney during diuresis to amount to one-tenth of the total taken by the whole body.

Prof. T. Clifford Allbutt suggested that the theories advanced as to the part played by oxygen offered some explanation of the fact, often experienced clinically, that the administration of oxygen gave relief to patients not only in cases where the heart and lungs were affected, but in many others also. He had long since given up the idea that oxygen was effective in these cases simply on account of the more favourable conditions under which the respiratory functions were placed. This was evidenced, for instance, by the tenacity with which the patients adhered to the treatment; for example, in cases of the vomiting of pregnancy, where its administration was often of great service.

Sir John Burdon-Sanderson, in bringing the discussion to a close, remarked that it had been an exceedingly fruitful one, and none the less so because the points under discussion had not been settled, but were still under investigation. It seemed clear to him that oxygen played two parts in metabolic processes, one of which was prominent in muscle, and was responsible for the final oxidation of explosive material, while the other, which was more accentuated in glands, was akin to a building up process, as it was involved in the elaboration of new material.

GEOLOGICAL NOTES.

THE puzzling and commonly fragmental remains styled by von Gümbel Lithiotis are the subject of an elaborate monograph by Dr. Otto Reis (*Abhandlungen der k.k. geol. Reichsanstalt*, Bd. xvii., Heft 6, 1903). After being considered as plants, from algæ to palms, for some twenty years, they settled down in 1890 as bivalve molluscs allied to oysters. Von Gümbel's revision, to this effect, is now revised by Dr. Reis, who points out that certain long ridges in the hinge-area represent teeth. Two genera, Cochlearites and Lithiotis, are established, forming the Lithiotidæ, a subfamily of the Spondylidæ. The minute structure of the shells is carefully described.

The interest aroused by the publication of "Bau und Bild Österreichs," recently reviewed in these columns, has called from Dr. Friedrich Katzer a series of papers (*Verhandlungen der k.k. geol. Reichsanstalt*, 1904, pp. 123, 150, 177, and 193), in which he hopes to fill some of the gaps still remaining in our knowledge of Bohemian geology. His work covers such widely diverse subjects as the zoning of the north-eastern coalfield under the Riesengebirge, and the magnetite-ores, occurring as separation-products in garnet-amphibolite, in the neighbourhood of Kutna Hora.

In the *Verhandlungen der k.k. geol. Reichsanstalt* for 1904 Herr R. Zuber (p. 200) explains his views as to the analogy of the Flysch deposits of Europe and those forming in tropical climates, with a heavy rainfall, in the neighbourhood of the mouths of rivers, whether these flow from continental land or from the members of an archipelago. Dr. H. Vetters (p. 134) interestingly connects the structure of the Little Karpathians with that of the eastern Alps on the one hand, and of the true Karpathians on the other. The Flysch of the north side of the Alps thus reappears from under the Vienna basin, and passes into the Karpathian Sandstone series; while the characteristic Karpathian "Klippen" are also traceable in this connecting range. The author regards the so-called Silurian grauwacke of Hainburg, down against the Danube, and similar rocks of the Leitha range, as in reality the equivalents of the Liassic beds in the Little Karpathians.

The *Jahrbuch der k.k. geol. Reichsanstalt* of Vienna usually contains more massive papers than the *Verhandlungen*, though it is difficult to discriminate between the two in scientific value. In vol. liii. of the former (1903), pp. 169–252, Dr. O. Ampferer describes, with numerous sections, the Triassic and Jurassic mountains that form the impressive broken country of crag and forest between Innsbruck and the Achensee. He illustrates his view of their structure (plate x.) by a skilful drawing of a relief-model, much in the American manner, thus emphasising the simpler anticlinal and synclinal structure in the south, and the great overfold of Trias upon a recumbent Jurassic synclinal in the Gamsjoch area. It seems possible, as the author points out, that the whole highland of Triassic rocks rests upon an underfolded and underthrust knot of younger strata. Dr. Ampferer modestly regards his own researches as supplementing, and correcting at certain points, those of Prof. Rothpletz and his Bavarian colleagues. He adds, moreover, details as to the glacial phenomena throughout the district. Herr E. Fugger's paper in the same volume (p. 295) describes the foothills of the Alps in the famous Salzkammergut area, where the Flysch, with its dubious fossils, forms the oldest series, and is confidently ascribed to the Upper Cretaceous epoch. Dr. F. Ryba (p. 351) revises and amplifies the list of fossil plants from the Cannel Coal of Nýřan in Bohemia, and Dr. Waagen (p. 443) adds to our knowledge of the small brachiopods characteristic of the Tyrolese Trias.

We have received the August number of the *Quarterly Journal* of the Geological Society, which contains a well illustrated article on the history of volcanic action in the Phlegræan Fields by Prof. Giuseppe de Lorenzo; an account of the discovery of a human skeleton in Gough's Cavern, at Cheddar, by Mr. H. N. Davies, who regards the remains as of late Palæolithic age, although in the discussion which followed the reading of the paper this antiquity was questioned; and among other papers there is an important one on the age of the Llyn-Padarn dykes in Carnarvonshire by Mr. J. Vincent Elsden, who regards these deep-seated intrusions as having taken place during the latest stage of the Bala eruptions.

The summary report of the Geological Survey Department of Canada for 1903 has been issued by Dr. Robert Bell, the acting deputy head and director. As usual, the energies of the staff have been given mainly to investigating and aiding the development of the mineral resources of the country. Field work has been carried on in Yukon territory, in British Columbia, in the Keewatin district, in Ontario, Quebec, New Brunswick, and Nova Scotia. In connection with the large output of coal which is now going on in

both Nova Scotia and Vancouver Island, it is mentioned that the only coal known to occur in North America on the immediate seaboard of either the Atlantic or Pacific belongs to Canada.

Some new genera of Carboniferous Mollusca from the United States have been described by Mr. G. H. Girty (*Proc.* U.S. National Mus., vol. xxvii., No. 1372). They include Limipecten, a form considered to be near to Aviculipecten (*sic*), and with that genus to have affinities with the Pectinidæ rather than with Aviculidæ. Other new genera are Pleurophorella, allied to Allerisma, and Clavulites, having some resemblances to Dentalium.

The Miocene diabase of the Santa Cruz Mountains in San Mateo County, California, is described in some detail by Messrs. H. L. Haehl and R. Arnold (*Proc.* Amer. Phil. Soc., vol. xliii., No. 175). The diabase, in the form of tuffs, dykes, and intrusive sheets, occupies about 35 square miles in an area of 300 square miles. It is remarked that the tuffs are interbedded with Miocene limestones, sandstones, and shales, and that intrusions of limestone derived from the interbedded limy layers have been forced into fissures in the tuff. In the intrusive diabase the percentages of soda and titanium are large, and it presents the characters of augite-teschenite.

An essay on the palæontology of the Lancashire Coal-measures, part i., contributed by Mr. H. Bolton to the *Transactions* of the Manchester Geological and Mining Society (vol. xxviii., part xiv.), has been reprinted as one of the "Museum Handbooks" of the Manchester Museum, Owens College (price 1*s*.). In this work the author deals with the lower Coal-measures, and his object has been to record the horizon and geographical occurrence of each species so far as possible by reference to known specimens.

Prof. G. A. J. Cole and Mr. T. Crook have reported on rock specimens dredged from the floor of the Atlantic off the west coast of Ireland in 1901 (Dept. of Agric. and Techn. Instruction for Ireland, App. to part ii. of Rep. on Sea and Inland Fisheries). The rocks which were obtained off the west coast of Mayo and Galway appear to have been derived from submerged masses of rocks familiar in western Ireland. They include also an olivine-gabbro which is regarded as probably of Carboniferous age.

In an article published in the *Land Agents' Record* (August 20) Mr. F. J. Bennett directs attention to the important uses to which the Ordnance Survey maps, on the scale of 25 inches to a mile, might be put for estate and agricultural purposes. As he points out, much valuable information is lost, both to the landowner and farmer, to say nothing of the geologist, for want of recording it at the time. He instances the nature of the soil and subsoil as proved in draining the land and in various temporary excavations, as well as information with regard to wells, springs, stone quarries, or clay pits. The courses of the drains have rarely been laid down on estate maps. In addition to records of these matters, he suggests that the maps be used also for statistics with reference to cultivation. Thus the amount of seed sown, the kind and quantity of manure used, the weather, and, finally, the result of each field crop might be notified. If these particulars were tabulated, say for seven years, the reasons for success or failure might be judged. In the transfer of property or of leases such information would be of the utmost value to the incoming owner or tenant, and the records, which would be the private property of the occupier, should be of sale value.

We have received a number of important geological publications from South Africa. In the *Transactions* of the South African Philosophical Society (vol. xv., part ii.) Mr. E. H. L. Schwarz describes the high-level gravels which cap the flat-topped hills all over the southern coast regions of Cape Colony. The evidence shows that the gravels were river-borne, and in the Karroo district they yield gold. No gold-bearing reef has, however, been detected in that area, and the author is strongly of opinion that the gold came from the Zwartebergen, where it occurs in the Table Mountain Sandstone. Messrs. A. W. Rogers and A. L. du Toit describe the Sutherland volcanic pipes and their relationship to other vents, notably those of Kimberley. In the *Transactions* of the Geological Society of South Africa (vol. vii., part i.) there are various papers of local interest on the geology of the Transvaal, and on the Witwatersrand series in particular. In the annual report of the Geological Commission of the Cape of Good Hope for 1903 we have a record of the careful detailed work carried on by the director, Mr. A. W. Rogers, and his staff. The survey of the south-western portion of the Karroo has been completed, and much information has been gathered with reference to the sedimentary and volcanic formations. The recognition, in the Verloren Valley, of a group of rocks (the Ibiquas series) between the Table Mountain Sandstone and the Malmesbury series is of considerable interest.

"The Geology of the Country around Merthyr Tydfil" (being the fifth part of the "Geology of the South Wales Coal-field") has just been issued by the Geological Survey, price 1*s*. 6*d*. It is the work of Messrs. A. Strahan, Walcot Gibson, and T. C. Cantrill, and is an explanation of the geological map sheet 231. The area includes the North Crop of the Coal-field from Dowlais to the Tawe Valley, with a considerable tract of Old Red Sandstone in the mountainous land of Fforest Fawr, and also of Lower Carboniferous rocks. The great scarp of the Pennant Sandstone stretches across the country on the south. The stratigraphical features, the lithology, the faults and disturbances of this important coal-region are dealt with very fully; the Glacial drifts and other superficial deposits are duly described, and a short chapter is given on the economic products.

We have received an official report by Signor A. F. Umlauff on the Cinnabar of Huancavelica, issued as a *Boletin* of the Corps of Mining Engineers of Peru. The ore occurs in irregular deposits in sandstones and limestones, which have yielded Cretaceous fossils, and sections are added showing its mode of occurrence. A description is also given of the aludel furnaces, which are used in extracting the mercury, and have remained practically unchanged for more than two centuries.

From the United States Geological Survey we have received *Bulletin* No. 228, dealing with analyses of rocks from the laboratory, 1880 to 1903, by Mr. F. W. Clarke; also *Professional Paper* No. 28, giving the superior analyses of igneous rocks from Roth's Tabellen, 1869 to 1884, arranged according to the quantitative system of classification.

The occurrence of a "calcareous coal" in the Lanarkshire Coal-field is described by Mr. R. W. Dron (*Trans.* Inst. Mining Engineers, vol. xvii.), and shown by analysis to contain carbonates of lime and magnesia. The author seems to have been unaware that Mr. A. Strahan, in 1901, brought before the Geological Society an account of the passage of a seam of coal into dolomite, as observed at the Wirral Colliery in the small Parkgate Coal-field.

The glaciation of Mount Ktaadn, in northern Maine, forms the subject of an essay by Mr. R. S. Tarr (*Bull.* Geol. Soc. Amer., vol. xi.). The mountain, which is composed of granite, rises to a height of 5150 feet, and has hitherto been regarded as bearing no proof of ice-covering during the Glacial period. The author brings forward evidence to show that the ice did overtop the mountain, and that glaciers subsequently occupied the valleys on its eastern side, leaving well defined moraines some of which enclose lakes.

In the *Brazilian Mining Review* (for April and May) Mr. H. Kilburn Scott gives some account of the mineral resources of Rio Grande do Sul, which is the southernmost of the States of Brazil. The village of Lavras is at present the centre of the gold-mining industry, the gold occurring in quartz-veins or as impregnations in decomposed syenite-rock. The principal copper deposit is that of Camaquam, and the ores comprise copper glance, copper pyrites, and bornite (erubescite). Lodes occur in hard conglomerates and sandstones which have been invaded by melaphyre, and there seems to be a close connection between these metalliferous deposits and the eruptive rock.

A useful index to the mineral resources of Alabama, compiled by Messrs. E. A. Smith (State geologist) and H. McCalley, has been issued by the Geological Survey of Alabama. It includes an account of iron and manganese ores, bauxite, coal, clays, building stones, mineral paints, mineral waters, &c., and is illustrated by a small geological map and pictorial views.

The tin deposits of the York Region, Alaska, are briefly described by Mr. A. J. Collier (*Bulletin* No. 229, U.S. Geol. Survey). Stream tin was discovered in 1900, and since then

prospecting has been going on to determine its extent and to locate its source in the bed-rock. The ore is mostly cassiterite, but stannite also occurs. Pebbles of slate containing small tin-bearing quartz veins have been found in the gravels, while elsewhere the ore has been found disseminated through more or less altered granitic dykes.

PRIZE SUBJECTS OF THE INDUSTRIAL SOCIETY OF MULHOUSE.

THE Industrial Society of Mulhouse has issued a programme of the prizes to be awarded by the society in 1905; excluding the subjects which are of a purely local or technical character, the following are the principal prizes open to competition to all nationalities:—

In the section of chemistry, medals of honour will be given for experimental investigations of the alizarine reds, of the colouring matter of raw cotton, of the transformation of cotton into oxycellulose, and of cochineal carmine; for the synthesis of the colouring matter of cochineal or of some other dye used in industry; and for the production of fast dyes of a specified nature. Several medals will also be awarded for studies of special mordants and for the synthesis of some naturally occurring substance. A sum of 500 francs to 1000 francs is to be allotted to the best compilation of densities of mineral and organic substances in the solid state and in cold saturated solution. Many practical chemical problems in the bleaching and dyeing of cotton, wool, and silk are also suggested as subjects for competition.

In the section of mechanical arts, a prize of 500 francs and a silver medal is offered for a new method of construction of buildings suitable for cotton spinning, wool combing, or calico printing. The following subjects will receive medals:—a new non-tubular type of boiler; an indicator of the total work done in a steam engine; a new system for heating steam boilers; various machines for combing, carding, and weaving the textile fibres; a comparative study of electric and gas lighting in factories; a system of automatic lighting by conductors of the second class.

The following subjects deal with natural history and agriculture:—a catalogue of the plants in the neighbourhood of Mulhouse, Thann, Altkirch, and Guebwiller; an account of the fauna of Alsace; a mineralogical or geological description of part of Alsace; a study of the plants or insects inimical to agriculture in the same province. A medal is also offered for an investigation of the character of Alsace in prehistoric times.

In the sections of commerce and statistics the subjects are:—a consideration of the questions of insurance against risks of transport and fire; the influence of taxation on industry; and the effect of trusts and like organisations on commerce.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. J. J. Lister, F.R.S., of St. John's College, has been appointed demonstrator of comparative anatomy.

The Board of Geographical Studies has arranged for a course of instruction in geographical surveying, to be given by Mr. Hinks at the observatory.

The council of the Senate proposes an important scheme whereby the matriculation and senior local examinations of the Universities of London, Oxford, and Cambridge shall be mutually recognised. The object is to diminish the number of distinct examinations for which schoolmasters have to prepare their pupils. The proposed conditions are set forth in the *University Reporter* for October 11.

Mr. R. R. Webb, St. John's, Mr. G. H. A. Wilson, Clare, Mr. J. M. Dodds, Peterhouse, and Mr. E. W. Barnes, Trinity, will be the examiners for the mathematical tripos, part i., in 1905.

SIR ISAMBARD OWEN has been appointed principal of the Durham College of Science in place of the late Dr. Gurney.

DR. ARTURRO MARCACCI, of the University of Palermo, has been appointed professor of physiology in the University of Pavia.

DR. HERMANN KOSSEL, of the Imperial Board of Health at Berlin, has been appointed to the chair of hygiene at the University of Giessen in succession to Dr. Georg Gaffky.

THE first congregation to inaugurate the University of Leeds was held on October 6, and the honorary degrees announced in our issue of September 29 (p. 547) were conferred. The Chancellor of the university, Lord Ripon, presided.

WE learn from the *Athenaeum* that Dr. Hans Batterman, of the Berlin Observatory, has been appointed director of the observatory at Königsberg, and professor of astronomy at the University of Königsberg, in succession to Prof. Hermann Struve, lately appointed to the vacancy at Berlin caused by the retirement of Prof. Förster.

THE Board of Education has issued its "Syllabuses and Lists of Apparatus" applicable to schools and classes other than elementary from August 1, 1904, to July 31, 1905. A new subject, under the title "Elementary Science of Common Life (Chemistry)," number twenty-six, has been added to the list of branches of science in which the board holds examinations. The list of subjects in which no examinations are held, though the subjects are recognised by the Board, has been extended, and now includes many subjects introductory to more advanced work in technology.

THE anonymous gift of 1000*l*. to the University College of Bristol announced a few days ago is, it may be hoped, an indication that the work of this institution is being appreciated in Bristol and the surrounding district. In addition to the usual courses, appropriate and systematic instruction is given at the college in those branches of applied science which are most nearly connected with the arts and manufactures. We notice that the total number of individuals, excluding medical students, attending the college during the session 1903–4 was 1084, of whom 596 were day students.

THE new calendar of University College, London, that for the session 1904–5, gives full particulars of several interesting new developments in the work of the college. The university courses of study, especially those in economics, have been extended, and further arrangements have been made for post-graduate courses, lectures, and research—this post-graduate work is explained fully in ten pages of the calendar. The list of papers and other publications from the scientific departments of the college, since the Dean's report of last year, runs to eight full pages, and shows that the work now being accomplished in the college is of the same high order as in previous years.

IT is reported that there is apparently a deficiency of about 2000*l*. for the annual working expenses of the Tata Research Institute, and on account of this the scheme for the institute is at a standstill. Referring to this, *Capital* remarks:—"The question now is whether for the sake of two or three thousand pounds India should go without a Research Institute. Is the object good or not? If it was not good, why did the Government of India promise to help it? If it is good, why should there be any stinginess on their part about it? Should a great Government refuse its support and countenance to a scheme, the expenditure on which will be repaid not only to the people of India, but also to the Government itself a hundredfold?"

THE buildings of the new technical college at Danzig were opened on October 6 in the presence of the German Emperor. The college, which has been established on a modern basis, is intended to develop the industries of West Prussia and of the city of Danzig. Shipbuilding is to receive special attention. In a speech which he made, the Emperor referred to the importance of technical education for the maintenance of Germany's position among the nations, and described the special characteristic of the German technical colleges as being their "comprehensive many-sidedness." It is, he continued, for this reason that these colleges constitute a scientific "Universitas" which may be compared justly with the old universities, and explains why the endeavour has been made to place the two kinds of institutions on an equal footing by bestowing upon the technical colleges the right to confer degrees. "May the new college," the Emperor concluded, "prosper and flourish to the glory of German learning, to the blessing of these old Prussian provinces, and to the honour of the German name!"

A RESOLUTION adopted by the manufacturers' section of the London Chamber of Commerce, and approved by the council of the chamber, was recently forwarded to the Board of Education together with a letter from the secretary of the chamber expressing the views of the manufacturers more explicitly. The resolution states that, in order to retain our industrial position and to introduce into this country such further industries as may be profitably developed, the manufacturers' section is of opinion that it is absolutely necessary to raise the standard, and, if possible, cheapen the cost of technical and higher technical education, and that representations should be made to the Board of Education in this sense. The letter to the Board of Education points out that up to the present time manufacturers in this country have not realised that there is a scientific aspect to every branch of manufacture, requiring study to attain the highest results, and that there is hardly an industry that would not benefit from the more general employment of specially qualified scientific assistants. At present such qualified assistants as are available are mostly foreigners, the letter continues, and there is urgent necessity for providing greater facilities for obtaining a thorough training in applied science in this country. There would seem to be urgent need for technical colleges of university type in connection with each industry, where students could have opportunities of carrying out specialised study and research work under competent teachers. The fees charged should not be greater than those charged by similar Continental institutions, and poorer students of ability should be assisted by a liberal system of scholarships. Mr. Morant, replying on behalf of the Board of Education, says the board is keenly alive to the importance of encouraging a better provision of higher technical education than at present exists, and will take every step in its power towards its promotion. But these efforts will be largely in vain unless British manufacturers give every encouragement in their power to promote the employment of students at home thoroughly trained for the needs in question. Mr. Morant rightly points out, with reference to the considerations submitted, that the want of properly qualified English assistants referred to may be attributed partly to the fact that the salaries offered are frequently too low to tempt natives of this country, partly to the shortsightedness of many English parents in refusing to continue their sons' education to a sufficiently advanced point, partly to the fact that there is no adequate provision at present in Great Britain for enabling persons to acquire the manipulative skill necessary in certain branches of industry, and partly also to the inadequate endowment and the insufficient encouragement of research.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 3.—M. Mascart in the chair.—A comparison of the expenditure of the flexor and extensor muscles of the forearm, applied, each group separately, to the production of the same continuous external work: A. **Chauveau.** The energy expended was measured by means of the respiratory coefficient. It was found that the external work effected by the flexor muscles of the forearm was less than that of the extensors, the proportion being about 0·4 for the former and 0·6 for the latter. This difference appears to be due exclusively to the less favourable conditions under which the extensor muscles work.—On the loss of electricity in air in the neighbourhood of thermal springs: A. B. **Chauveau.** In the thermal springs at Cauterets, the radio-activity of the air near the spring was clearly marked, the loss observed in the neighbourhood of the reservoir being three times as fast as in the open air.—The colorations produced by the Becquerel rays; its application to crystallography and to the calorimetric determination of radio-activity: C. J. **Salomonsen** and G. **Dreyer.** The coloration produced by radium on certain crystals demonstrates the zonal structure of the crystal, and thus throws light upon the manner in which it has been built up. In the case of quartz, this zonal structure has not hitherto been demonstrated.—On a vacuum effect produced by a waterspout: Léon **Pigeon.**—On actinium: A. **Debierne.** The substance previously described by the author under the name of actinium presents many similarities with the emanium of Giesel. The opportunity has recently arisen of directly comparing the two substances, and the observations of M. and Madame Curie, M. Giesel, and the author on the characteristic phenomena of phosphorescence provoked by the two products shows that they are identical. The name emanium should therefore be dropped in favour of the earlier actinium.—The properties and constitution of the molybdenum steels: Léon **Guillet.** The series of steels studied contained only 0·2 per cent. of carbon, with molybdenum increasing from 0 per cent. to 15 per cent. A second series contained about 0·85 per cent. of carbon. In small quantity, molybdenum increases the breaking load without causing extra fragility. The general properties of the molybdenum steels resemble those of tungsten steels, but four times as much molybdenum as tungsten is required to produce the same results.—A thermochemical comparison between rosanilines and leucanilines: Jules **Schmidlin.**—On the morphology of the Chetoptera: Ch. **Gravier.**—The archaic form of the Thecosome Pteropods: Paul **Pelseneer.**—On the structure of the muscles of *Anomia ephippium*: F. **Marceau.**—On acarophytism in Monocotyledons: E. **de Wildman.**—Semeiology of the prostatic secretion: A. **Guépin.**—On a new treatment of seeds: E. **Bréal** and E. **Giustiniani.**

NEW SOUTH WALES.

Linnean Society, August 31.—Dr. T. Storie Dixson, president, in the chair.—Revision of the Australian species of Bolboceras (Coleoptera, fam. Scarabæidæ), with descriptions of new species: Rev. T. **Blackburn.**—Studies in Australian entomology, No. 14, new species of geodephagous Coleoptera from Queensland and North-West Australia: T. G. **Sloane.** Three additions to the Cicindelidæ and five to the Carabidæ are proposed as new.—The botany of Funafuti, Ellice group: J. H. **Maiden.** The author gives a list, with critical notes, of thirty-eight dicotyledons, eleven monocotyledons, five vascular cryptogams, and one lichen. All the species are more or less widely distributed in the Pacific Islands as denizens of other coral islands or of the coastal tracts of the larger islands.

CONTENTS.

THURSDAY, OCTOBER 20, 1904.

ODORIFEROUS SUBSTANCES USED IN PERFUMERY.

Die Riechstoffe. By Georg Cohn, of Görlitz. Pp. viii+219. (Brunswick: Vieweg und Sohn, 1904.) Price 6 marks.

THIS useful little monograph is a section, published in separate form, of Bolley-Engler's "Handbuch der chemischen Technologie." It is not easy to find a single expression in English which could be regarded as the precise equivalent of the German "Riechstoff" in the sense used by the author. The term as here employed is meant to apply to odorous substances of a pleasant smell and of definite chemical composition—in other words, to chemical individual compounds having a more or less fragrant odour. It is obvious that the word perfume does not apply, because a perfume is generally a mixture of various odorous and non-odorous compounds, this being invariably the case with natural perfumes or fragrant plant oils.

The information contained in the present work is to be found in the larger treatises dealing with this subject, the works of Gildemeister and Hoffmann in Germany, of Charabot and his colleagues in France, and of Sawer in this country being familiar to all who are interested in this branch of chemical technology. The arrangement of the subject-matter by Herr Cohn, however, and the inclusion of the later discoveries entitle the little work under notice to take rank as an original contribution to the literature of this branch of applied organic chemistry. In fact, taking into consideration the large amount of information compressed into the volume, and the completeness with which the ground has been covered within a comparatively small compass, it may be fairly claimed that the treatment is more scientific and less technical than in the standard treatises referred to, and chemists who wish to get a general idea of the development of their science in this newer field will find the work of Herr Cohn a very valuable compendium.

The book is divided into ten chapters and an appendix. After defining the term "Riechstoff" in the sense above indicated, the literature of the subject is given in the second chapter, not the least valuable portion of which is a tabulated list of German patents classified under the chemical families to which the patents relate, such as alcohols, ethers, esters, aldehydes, ketones, &c. In the third chapter the historical development of the industry is dealt with, and it is pointed out that while perfumery as an art is of extreme antiquity, the scientific, *i.e.* chemical, history of the compounds employed is a comparatively recent development. The same may be said, it is perhaps hardly necessary to point out, of the tinctorial industry, which existed as an art ages before it came within the province of chemical science. The parallelism between these two branches of technology does not, however, end with this historical analogy, since the development of synthetical chemistry has enabled many natural odorous compounds to be made more economically than they can be obtained from natural sources, while many such compounds unknown in nature have been synthesised in the laboratory and transferred to the factory. The author gives (pp. 20–21) a list of twenty-one firms which are engaged partially or wholly in the manufacture of natural or synthetical perfumes. Of these, three are French, and the remainder German and Swiss. It is not apparent why English and other manufacturers have been excluded. The writer of this notice has a very distinct recollection, when examining the chemical products at the Paris International Exhibition in 1900, of seeing some very good exhibits of perfumes by English and colonial manufacturers. It is true that in the application of *chemical science* to the industry Germany and France are far ahead of this country, but this does not do away with the fact that we have a few factories here which ought at any rate to figure in any list having for its object the instruction of the public as regards the present state of any particular industry.

The fourth chapter, dealing with the occurrence of odorous compounds in nature and with plant physiology, is of particular interest. A list, occupying nearly nine pages, contains the names of all the plants, arranged under their botanical orders, which yield ethereal oils. Another set of tables, occupying twenty-one pages, gives at a glance the name of the ethereal oil, the part of the plant from which it is obtained, the botanical source, the yield per cent., the physical constants (sp. gravity and rotatory power), and the chemical constituents. These tables thus summarise in synoptical form the present state of knowledge of plant oils, and in view of their importance it is much to be regretted that the printing has not been arranged in a less confusing way. The entries, as read horizontally, run across both pages, and by the time the eye has reached the last column, containing the chemical constituents of the oil—to many readers the most important item of information—the connection with the particular oil named in the first column is lost or rendered ambiguous, and the entry has in many cases to be traced back again to make sure which oil contains such or such constituents. We are all familiar with, and have often been led astray by, this want of precise correspondence between the horizontal entries running across both pages of a railway time-table. If in future editions the horizontal entries could be divided by horizontal lines running across both pages there would be no ambiguity, and the tables would be very much enhanced in value.

An interesting point to which the author directs attention is the rarity of the ethyl group in natural ethereal oils. Methyl, propyl, allyl, propenyl, are all of widespread occurrence in the molecules of natural organic compounds—ethyl occurs but in a few exceptional cases, and some of these are doubtful. We could add many to the few cases of the occurrence of ethyl in natural products given by the author, but his general statement is nevertheless correct so far as our present knowledge goes. Extreme advocates of the temperance movement might even find scientific justification for their position in this fact, which is stated by Herr Cohn in the form of an aphorism:—

"Die Natur hat einen *horror* vor dem Alkohol" (p. 28).

Unfortunately for this argument, however, alcohol (ethyl) is itself a biochemical product.

The fifth chapter deals with the modes of preparation and extraction of odorous compounds, and with their synthetical production. The special part of the work (pp. 67–175), devoted to the description of the general modes of preparation of the various compounds classified under chemical families, may be looked upon as a chapter of synthetical organic chemistry having special reference to the formation of odorous compounds, and requires no further comment.

The headings of chapter vi. (physical properties of odorous compounds), chapter vii. (chemical characters and relations between odour and chemical constitution), chapter viii. (quantitative valuation), chapter ix. (physiological relations), and chapter x. (applications of odorous compounds) sufficiently indicate their contents. Chapters vii. and ix. will be found of interest to physiologists as well as to chemists.

We have not found many slips in this little monograph, and it can be safely consulted by all who are interested in the subject. The statement (p. 184) that *m*-oxybenzaldehyde derivatives do not occur in nature is erroneous (see, *per contra*, Jowett, *Trans.* Chemical Society, vol. lxxvii. p. 707). Haller's important partial synthesis of camphor from homocamphoric acid (p. 145) might have been mentioned in the reference given in the foot-note. The omission of English firms from the list on pp. 20–21, and the faulty arrangement of the tables on pp. 38–57, have already been referred to.

Those chemists who, without any special knowledge of the subject, will take the trouble to look through this volume cannot but realise that a new and important branch of industry has been developed out of the ancient art of perfume making. It is apparent also that this newer development is the direct outcome of the application of chemical science—the utilisation for practical purposes of facts and principles discovered by laboratory research. It is the history of the coal-tar colour industry re-told, and we may fairly ask, as in the case of this last branch of manufacture, what is this country doing in the matter? The writer does not propose to do more than raise the question here, because the set reply of "imperfection of patent laws" and "want of duty-free spirit" will no doubt be considered all-sufficient by the majority of our manufacturers. Passing over this point, however, there is another aspect of the modern perfume industry which is of particular interest. Concurrently with the development of synthetical processes and the introduction of new products, a keen and searching examination of volatile plant oils has for many years past been systematically carried out in the laboratories of several foreign factories. Without wishing to be invidious, the firm of Schimmel and Co., of Leipzig, may fairly be named as pioneers in this branch of work. The semi-annual report of this firm is a perfect mine of information concerning the chemical composition of ethereal oils. Now the detection of the chemical constituents of products resulting from the vital activity of plants is also a matter of physiological importance, so that the workers in this field—prompted, no doubt, primarily by practical considerations—are accumulating a stock of material for which plant physiologists ought to be grateful. Certainly no physiologist can afford to ignore this material, buried though it may be in a trade publication, and worked up without direct scientific aim. But the methods employed and the results achieved are as purely scientific and far more definite than much of the work that at the present time passes into literature as physiological chemistry. We have as pretty an illustration as modern times can furnish of the action of pure science upon industry, and the reaction of industry upon pure science.

R. MELDOLA.

SYSTEMATIC BOTANY.

The Classification of Flowering Plants. Vol. i. Gymnosperms and Monocotyledons. By A. B. Rendle, D.Sc. Pp. xiv+403. (Cambridge: University Press, 1904.) Price 10s. 6d. net.

THE practice which is gaining ground, whereby, to the exclusion of the general text-book, the specialist produces a book in which he takes up merely his own branch of a scientific subject, is satisfactory both from the point of view of the author and the reader. The author is well qualified to express his opinions, and the reader cannot fail to learn much from the critical exposition which he is tolerably sure to obtain. The book under notice is significant not only because it is written by one of our leading systematists, but also inasmuch as it is one of the first taxonomic treatises—another is Willis's "Manual of Flowering Plants and Ferns"—which follows Engler's system of classification. Bentham and Hooker's classification is followed in most British herbaria and collections, but there is much to be said in favour of training students in the system which, originally propounded by Eichler, has been modified by Dr. Engler, one of the principal reasons being that the arrangement of orders, although not developmental, at any rate provides a sequence which is distinctly helpful.

Regarding the title, whereas it is now recognised that the spore-bearing shoots of some of the Pteridophyta may be called flowers, Dr. Rendle has used the term in its ordinary signification, and the first volume deals with Gymnosperms and Monocotyledons, while a second volume will be devoted to Dicotyledons.

After a short historical review of the principal systems of classification which have been proposed, the author takes up the Gymnosperms, making six classes by the inclusion of the two fossil groups, the Cordaitales and the Benettitales. A chapter upon the morphology of the Angiosperms follows, after which the remainder of the book is concerned with the classification of the Monocotyledons.

The Gymnosperms have been very much to the fore of late years, and there is nothing strikingly new in the treatment of the group. The interweaving of the fossil classes is distinctly rational, and the reader will find a good general account, including the results of modern research. A considerable number of the distinctive features of the genera appear in the general account, and a few in the enumeration of the genera, but the latter might with advantage have been expanded.

Dr. Rendle has devoted much time to the Monocotyledons, so that it is with special interest that one turns to this part of the book. As might be expected, one finds here a valuable exposition of the morphology both of vegetative and reproductive organs, with a succinct account of all such doubtful and subtle questions as the morphology of the flower of Orchidaceæ, or the value of the vegetative body of the Lemnaceæ. A noticeable feature is the inclusion of so many facts concerned with the vegetative part of the plant. The various devices manifested by plants during germination, a subject in which the writer has made special investigations, receive very full treatment, and numerous anatomical details are mentioned; but perhaps more striking is the value which is attached to vegetative characters for the purpose of splitting the orders up into tribes. Thus in the Aroideæ anatomical structure and the leaf-nervature are considered by Engler to be the best distinguishing characters; in the Liliaceæ the vegetative habit is important; and Pfilzer makes use of several vegetative characters in separating the sections of the Orchidaceæ. It has already been pointed out that in the enumeration of the genera of the Gymnosperms it would be useful to have more details for comparing one with another, and the same applies to the latter part of the book, where geographical distribution is fully given to the exclusion of critical data. One misses, too, those broad generalisations, which serve as landmarks or guide-posts, until the last chapter—a most important one—in which the writer gives a general review of the important characters and relationships of the series and orders of the Monocotyledons. The author has had some difficulties with his illustrations, and the blocks prepared for the book, which on the whole have reproduced clearly, but are too crowded, suffer by comparison with the illustrations found in other descriptive works; otherwise the book forms a worthy and valuable addition to the standard series which is being issued by the Cambridge University Press, and will certainly be of very great use to students of botany.

A TEXT-BOOK OF NAVIGATION.

Modern Navigation. By W. Hall, R.N. Pp. viii+378. (London: W. B. Clive, 1904.) Price 6*s*. 6*d*.

THIS is a valuable text-book on navigation at a very moderate price. Its small size and general handiness are a great feature compared with other works on the subject. The proofs throughout the book are graphically explained so far as possible, and are easily intelligible to people with a limited knowledge of mathematics; the figures and illustrations are good, numerous examples are given throughout, and the answers are tabulated at the end of the book. The extracts from the "Nautical Almanac" necessary for working any of the examples are also given.

An excellent feature in the book is the great stress laid on navigation by "Sumner" or "position lines," which are the foundation of the present practice of navigation. Without a clear understanding of position lines it is impossible to comprehend the importance of the errors in position due to working with approximate data, such as finding longitude with D.R. latitude and *vice versâ*. These and other errors are thoroughly and clearly explained by the author; in many previous works these errors have been either neglected altogether or passed over without explanation of the methods used in compiling the tables given for their correction.

The method of obtaining position by combining position lines derived from a chronometer sight and from an ex-meridian is rendered complete by the plan given of calculating the final result by factors as opposed to plotting it. It is brief and accurate, and will be welcomed by those who have experienced the difficulties of plotting results in small ships in bad weather. A very short and accurate method of obtaining these results by the "nautical slide rule" is also given. The slide rule was Mr. Hall's invention, and is useful for ex-meridians and other computations.

The treatment of the short equal altitude as a dynamical problem tends to simplify the work, and renders it easier of comprehension. The chapter on the "new navigation" is much in advance of any previous discussion of this method; the explanation is clear and the work straightforward, and the figures required for the computation are reduced. An accurate means of obtaining the final result by calculation instead of plotting is also added to this method. Mr. Hall's treatment of the "new navigation" should greatly assist to popularise this valuable means of navigating, which is applicable to any heavenly body at any azimuth.

The investigation of errors due to inaccuracies in time and altitude is satisfactory, and many interesting problems in theoretical navigation are fully explained. A valuable feature in the book is the shortening of computation by using five places of logarithms and in some cases only four places. The chapter on tides is very simply and effectively written, and supplies a want much felt by seafaring men.

In a book where so much is good, it is a pity more stress has not been laid on the utility of twilight stars for position; the author refers to displacement of the horizon due to abnormal refraction, &c., as a cause of errors in position, but does not mention the best fix that can be obtained in the twenty-four hours at sea. Ex-meridians of stars north and south for latitude, and chronometers of east and west stars for longitude, the mean of the north and south stars for latitude and of the east and west stars for longitude, obviate the effects of displacement of the horizon, and the fix is not dependent on run between observations except to the extent of a few minutes. This fix is specially valuable to men-of-war, which, owing to manœuvres, are seldom long on a steady course, thereby causing the run between observations, taken at an interval of two or three hours, often to be inaccurate. The system of notation used throughout the book and the extensive use of Greek letters are likely to confuse men already practising their profession afloat and used to calling things by their old names; it will consequently not commend itself to them. Possibly young students

who have used this system of notation in other branches of their education may find it an assistance. In conclusion, the book may be recommended to anybody who practises navigation and wishes to keep up to date.

OUR BOOK SHELF.

Birds in their Seasons. By J. A. Owen. Pp. vi+145; plates. (London: G. Routledge and Sons, Ltd., 1904.) Price 2s. 6d. net.

COMPLETE originality in mode of treatment, perfection in literary style, absolute fidelity to nature in the illustrations, coupled with immaculate accuracy in regard to nomenclature and other technical matters, would appear to be the only possible justifications for adding a new one to the long list of popular works on British birds. If it be asked whether the volume before us fulfils these conditions, there will be no great difficulty in framing a reply. In the first place, the mode of treatment is by no means original; while the following sentence from p. 53, "When talking to Lady Farren, of Bealings House, Suffolk, she told me that her family had had remarkable intimacies with wild birds," can scarcely be regarded either as a sample of elegance in diction or of accuracy in grammar. As specimens of what illustrations, so far as regards colour, ought not to be, we may cite the figure of the bee-eater in the plate facing p. 16, and that of the kingfisher on the one opposite p. 32. As instances of technical inaccuracy, for which there is no excuse, we may quote the following (among other) misspellings of scientific names, viz., (p. 20) *Matacilla* for *Motacilla*, (p. 29) *Musicapa* for *Muscicapa*, (p. 54) *Cocothraustes* for *Coccothraustes*, (p. 104) *Dafilia* for *Dafila*, and (p. 129) *Acanthus* for *Acanthis*, the latter error being the more inexcusable from the fact that the name is correctly spelt on an earlier page. If further reference to inaccuracies be required, we may contrast the statement on p. 140, to the effect that in the index the various species are assigned to their respective orders and families, with the index itself, where in many cases the subfamily, in place of the family, is given.

If cheapness and (to the uninitiated) attractive illustrations were the sole qualifications for a good bird-book, the present volume might perhaps be worthy of commendation; as it is, naturalists at any rate still consider accuracy a *sine quâ non* in works of this nature, while the British public will, we venture to think, demand something strikingly original before it accords extensive patronage to a new history of British Birds. R. L.

The Cultivation of Man. By C. A. Witchell. Pp. xv+168. (London: W. Stewart, 1904.) Price 3s. 6d.

THE author of this book is very much in earnest. He condemns modern civilisation in strong terms for its many vices, especially for its worship of money and the mammonite marriages that result from it, and urges that men should apply to their own species the methods of the breeder of cattle. He recommends polygamy, apparently in all seriousness, and not as a mere counsel of perfection. It would, of course, destroy the family, but to this Mr. Witchell has no objection. He would have the child that is born "with every sign of some inherent disease of a serious character painlessly destroyed." Certainly he speaks out fearlessly, and that is no small merit. But it is to be regretted that he did not study his subject more before writing. "Natural selection," he says, "is sometimes operative, chiefly among the poor." Considering that in England nearly fifty per cent. of the population die before the average age of marriage, this is a wonderful understatement. If we bear the facts in mind, we can hardly agree with Mr. Witchell that the business man is "the surviving type," *i.e.* apparently the type that is to survive to the exclusion of others. Business men are not a separate species. There is a continual upward movement of able men from the great underlying social stratum, and from this stratum directly or indirectly our successful men, as we call them, have emerged. In the underlying *couche sociale* there is but little accumulation of capital and comparatively little marrying for money. As to style, Mr. Witchell uses his terms vaguely. We hear of the cultivation of the young (*i.e.* by education), and of cultivation by marriage (*i.e.* by selection). But in spite of its defects the book is, much of it, interesting. It dwells upon things which seem to be entirely unknown to Royal Commissions on degeneracy, and to the many people who write letters to the papers and articles in the magazines on the subject.

Richard Meyer's Jahrbuch der Chemie for 1903. Pp. xii+600. (Brunswick: Vieweg und Sohn, 1904.) Price 15 marks.

THE year-book for 1902 has already been reviewed in these pages, and what was then stated applies with little modification to the new volume. Meyer's year-book presents an excellent, though necessarily brief, *résumé* of the year's researches in pure and applied chemistry. Possibly in other hands a slightly different selection might be made, and the weight of emphasis otherwise distributed, but in the rather wide range of subjects which have to be dealt with the question of choice must naturally vary with the taste of the individual reviewer.

Although, as was previously remarked, the small proportion of contributions of English authors does not accurately represent the relative strength of English chemistry either in quantity or quality, it is only too true that our output in chemical research and chemical literature is below what it should be. That this is due to lack of interest or poverty of ideas no one could admit, but it is to be attributed to the want of proper facilities in the way of public encouragement and State assistance.

Meyer's year-book has now reached its thirteenth year, and its success, which is assured, must be placed to the credit of its excellent staff of reviewers.

Perhaps its one shortcoming, if one may so express it, is that it is so long in coming, and many of the researches which are catalogued have assumed a new phase before the year-book appears. J. B. C.

Astronomischer Jahresbericht. By Walter F. Wislicenus. Vol. v. Containing the Literature of the Year 1903. Pp. xxxiv+660. (Berlin: George Reimer, 1904.) Price 20 marks.

IT was thought that the publication of the volumes on astronomy, a part of the "International Catalogue of Scientific Literature," might affect and possibly put an end to this most useful and valuable German publication, but the appearance of this, the fifth yearly issue, renders such an idea untenable. The volume before us is full of vitality and vigour, and the compiler and his co-workers are to be congratulated both on the high standard they maintain throughout such a laborious task and on the great value of the publication to all astronomical workers. To have not only references, but brief summaries of the contents of all, or practically all, astronomical literature published

during the past year is a real help to the astronomical investigator, and saves him much time and labour. In spite of the mass of material that is embodied in the work, the volume is, according to pages, only a trifle larger than its immediate predecessor, and somewhat smaller than vol. iii. As a matter of interest, it may be stated that the number of references in the present and the two preceding volumes are 2582 for vol. v., 2411 for vol. iv., and 2513 for vol. iii.

In conclusion, the statement made with regard to the earlier volumes, namely, that they should be found in every astronomical library and observatory, may be repeated in the present case. W. J. S. L.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Forest-pig of Central Africa.

I have seen Mr. Oldfield Thomas's interesting letter in your issue of October 13 relative to the remarkable forest-pig (which he has named *Hylochoerus meinertzhageni*). With regard to the discovery of this remarkable beast, there are perhaps other names which should be associated with it as well as those of the late Sir Henry M. Stanley and myself. No mention of this forest-pig appears in Sir Henry Stanley's published works, but in conversation with myself and others he frequently told us that, in addition to hearing of a "donkey-like animal with large ears" (which afterwards turned out to be the okapi), he once saw a huge black pig, and he had reason to believe that a strange new species or genus of pig inhabited that portion of the Congo Forest near the Semliki River. I heard and transmitted similar stories told me by the natives of that forest; but even more detailed accounts were collected and sent later on by the late W. G. Doggett, who, to the great loss of zoological collecting in Africa, was drowned in the River Kagera in the early part of the present year. But I think the first definite accounts of this pig (or at any rate of *Hylochoerus meinertzhageni*) were transmitted by Mr. C. W. Hobley, C.M.G., a sub-commissioner of the East Africa Protectorate, who has recently been acting as Commissioner after the departure of Sir Charles Eliot. Mr. Hobley sent a drawing of the skull and a description of the creature from imperfect specimens he had seen on the slopes of Mount Kenia. Unfortunately his letters were delayed in transmission, so far as their reaching the Zoological Society was concerned. Mr. Hobley is now in England, and it is to be hoped that he will furnish the Zoological Society in detail with the extremely interesting particulars he has given me in conversation regarding this remarkable animal. I would remind your readers that Mr. Hobley (who as regards length of service is almost the senior British official connected with British East Africa) made the important discovery last year of marine organisms in the Victoria Nyanza.

So far, the native stories of the okapi and the big forest-pig have turned out to be true. It only remains to complete the trilogy by the discovery of a third mysterious animal, also alluded to in conversation, if not in writing, by Stanley, and mentioned by Doggett and myself. This, so far as native accounts can be crystallised into a definition, would seem to be some large tragelaphine antelope resembling the nilghai in appearance, with short, twisted horns. A horn or a pair of horns attributed to this animal was, I believe, brought home by a member of Stanley's expedition, and is possibly in the British Museum. It was seen by Dr. P. L. Sclater, and attributed by him to an abnormally developed cow eland; but so far as I could learn from my own researches and those of Doggett, the natives of the Semliki Forest were careful to differentiate this creature from either the forest eland or the bongo. Their accounts of it certainly coincide to a great extent with their stories of the okapi, though they insisted on the difference between the two animals. Perhaps there is as much truth in their stories of this large antelope with small twisted horns as there has been shown to be in connection with the okapi and the forest-pig. H. H. Johnston.

Mendel's Law: a Crucial Experiment.

I see from the published account of a recent discussion at the Cambridge meeting of the British Association that the facts of Mendelian segregation are still disputed by the biometric school of evolutionists. I venture, therefore, to submit to your readers the result of an experiment carried out at the Royal Botanic Gardens, Peradeniya, which, in my opinion, proves conclusively that in a particular cross-bred form a particular pair of characters did become segregated in equal numbers of germ cells, both male and female. The characters in question were:—the appearance and absence respectively of a yellow coloration in the endosperm of grains of Indian corn (*Zea Mays*). These characters are discontinuous in the strain examined. Among about 100,000 grains which passed under my notice, I saw only two which were partly yellow and partly white; these were counted as yellow, being presumably heterozygotes.

Some of my specimens were exhibited by Mr. Bateson at the recent meeting of the British Association, but I can now add the results of a further generation.

The facts are represented in the following scheme, in which the absence of the yellow pigment is expressed by the term "white."

I. {(1) White flint corn; extracted recessive from a mongrel strain} ♀ × ♂ {(2) Yellow flint corn; of the same mongrel strain as (1)}

II. {(3) Yellow grains} ♀ × ♂ {(4) Offspring of (1); self-pollinated white}

III. (5) 1963 yellow (49·76 per cent.) + (6) 1982 white.

The plants arising from these grains, both white and yellow, were used as seed parents in the next generation, the pollen parent being "Boone County White" dent corn. There resulted:—(*a*) Offspring of white grains—some 30,000 white grains and 27 yellow grains (0·09 per cent.); the latter were accounted for by the escape of "yellow" pollen. (*b*) Offspring of yellow grains—generation iv.:—

IV. 26,792 yellow (50·03 per cent.) + 26,751 white.

(Self-pollinated)

V. 16,582 yellow + 5681 white (25·5 per cent.)

The plants arising from the above yellow grains (generation iv.) were also used as pollen parents for a cross in which the seed parents were the offspring of "Boone County White" crossed with a strain of extracted recessives from the original mongrel flint corn. There resulted:—

2507 yellow (49·2 per cent.) + 2593 white.

I would direct particular attention to the following points:—

(1) That a perfect Mendelian result was obtained among the offspring of an impure race.

(2) Lest it should be objected that possibly the ancestry of this mongrel strain included equal numbers of yellow and white individuals, a pure recessive strain ("Boone County White," imported from U.S.A.) was introduced into the pedigree, so that the next generation (iv.) possessed at least three times as many white ancestors as yellow. On self-pollinating the offspring of yellow grains, the Mendelian proportion 3 yellow to 1 white was obtained.

(3) In two generations the female germ cells borne upon the heterozygotes were tested by crossing with the recessive form. In each case half of the germ cells were found to

bear the yellow character and half of them the white. In the last generation a similar test was applied to the male germ cells with the same result.

(4) The experiments were carried out under fully "biometric" conditions, the more accurate "Mendelian" method of careful pollination between individual plants being deliberately avoided. Thus, in generation iv. pollination was effected by the aid of the wind from some 1800 recessive parents indiscriminately.

A somewhat fuller description of the early part of this experiment has already appeared in vol. ii., part ii., of the *Annals* of the Royal Botanic Gardens, Peradeniya, and a complete account will be published in a future number of the same journal. R. H. LOCK.

Peradeniya, Ceylon, September 21.

Rock Pressure at Great Depths.

IN his address to the engineering section of the British Association, Mr. Parsons speaks of sinking a shaft into the earth for a distance of 12 miles.

I think, however, he overlooks a factor which sets a limit to the depth to which a mine shaft can be sunk. If we assume that the average specific gravity of the earth's crust is 3, the superlaying rocks would exert at a distance of 12 miles a pressure of about 440 tons per square inch.

There can be little doubt that when subjected to such a pressure the rock material would give way and flow together like a viscous fluid, and so the walls of the shaft would spontaneously close up, probably before the depth of 12 miles was reached. The breaking stress of steel is only 44 tons per square inch, and so, even were the walls encased by a steel tube, this would not avail to prevent the flowing together of the walls. GEOFFREY MARTIN.

Kiel, Preusser-str. 19[I], September 17.

I HAVE to thank you for directing my attention to Mr. Martin's letter in which he gives his views as to the probable behaviour of rock around a very deep shaft boring, and his opinion that the inward viscous flow of the rock would place a limit to the possible depth.

I have to thank Mr. Martin for directing attention to the question of this possible limitation, which was considered when writing my address and dismissed as unlikely to occur up to depths of 12 miles, basing my conclusion on general engineering knowledge of the flow of metals, of the relative impressions made on hard brass and on hard rock when struck by hard steel tools, and on the general behaviour of metal when forged.

I must first beg leave to point out some errors in Mr. Martin's figures; he has misplaced the decimal point in calculating the hydraulic pressure of the superlaying rocks at 12 miles depth, which should be 40 tons and not 440 tons per square inch.

Again, of the crushing stress required to make hardened steel flow I have no data by me, but am aware that it lies between 120 tons and 300 tons per square inch, and in the case of hardened knife edges for weigh bridges, if my memory is correct, the pressure per square inch on the area of contact reaches a still higher figure.

Again, the pressure required to make the tough brass ("cartridge metal") flow is about 80 tons per square inch.

I think that the evidence at present available leads to the conclusion that after a small amount of shrinkage of the shaft sides inwards has taken place a state of equilibrium would be established enabling the surrounding rock in its state of great compression to withstand the so-called hydraulic pressure due to a depth from the surface of at least 12 miles.

Since my address I have had the opportunity of discussing the matter with Prof. G. H. Darwin, who has kindly brought to my notice the article by Tresca, "Memoirs des Savants étrangers sur l'écoulement des Corps solides," about the year 1866, and also his own paper in the *Philosophical Transactions* of the Royal Society, part i., 1882, in which the great shearing stresses that are thrown on the earth's structure by the weight of mountain ranges on elevated continents and great depths of the sea are exhaustively treated. I would only point out that such stresses have been endured for long epochs, and that in view of the established fact that rocks are viscous, it is clear that much greater stresses could be sustained for the comparatively short time necessary to complete a deep shaft boring.

It would, however, be interesting to subject a cylinder of granite or quartz rock, carefully fitted into a steel mould and having a small hole bored through its centre, to a pressure of, say, 100 tons per square inch, and see what shrinkage in the hole would result, or a hole might be bored into the specimen through an aperture in the mould while subjected to this pressure. This pressure would correspond to a depth of about 38 miles.

CHARLES A. PARSONS.

Holeyn Hall, Wylam-on-Tyne, October 7.

The Berlin "Thinking" Horse.

IN your issue of September 22 there is a paragraph among the notes (p. 510) with reference to "Clever Hans," a "thinking horse" at present displaying his powers in Berlin. With reference to it I wish to say that twelve or thirteen years ago there was on exhibition in the Royal Aquarium, London, a horse of, if I mistake not, exactly the same stamp. I happened to be then attending lectures at the Royal College of Science, and I went to see the animal. I had, moreover, a long conversation with his trainer, who eventually let me see exactly how it was all accomplished.

With all respect to the members of the "representative committee" at Berlin, I am driven to hold that the performances recorded, counting the number of the audience, picking out the tallest man present, telling the hour, &c., which seemed so deeply to impress them, partake of the nature of a stage trick. They demonstrate what training and perseverance can do with animals rather than the possession on their part of any advanced mental powers.

The Aquarium horse was named, if I remember aright, Mahomet. He could work sums in addition and subtraction, or, for that matter, in multiplication, could count the number present in the little side-show, could make a good guess at the age of an individual, and so on. He had been taught to begin pawing the ground when his trainer looked straight at him, and to cease when the trainer turned his gaze to the floor. It is easy to see the countless changes that can be rung on this accomplishment. Telling the time on a watch or the day of the month are readily recognised to be among them. Similarly, he had been drilled into bowing his head at one tone of his trainer's voice, and shaking it on hearing another. Again one can readily imagine how this bit of instruction will lend itself to a very varied and wonderful display of cleverness.

Mahomet's owner was an American and followed the business of training horses, especially circus ones. This horse, he discovered, was very easily taught—a genius among his kind—and on him he then lavished years of most careful labour, often, he assured me, sleeping of nights in the manger at his head. The results were as shown. They were in themselves sufficiently marvellous, and represent, I fancy, the very utmost that a horse can be trained to do. "Clever Hans" would seem to be blessed with a trainer as painstaking and persevering as my American friend.

After a *séance* which I had all to myself, Mahomet's owner delayed with me to see the performance of a clever dog on the central stage. The dog, a fair specimen of a rough collie, answered questions, spelt his own name, words sent up by the audience, &c. The letters of the alphabet were placed in order in a wire frame towards the back of the stage. The collie went along the letters, picked out the one he needed, and brought and laid it before the footlights. He then went for the next. Wonderful I thought the performance until my friend the horse-trainer showed me how it was done. The collie always began at A. He then trotted along up the alphabet until he reached the one he needed. His master carried his gloves in his hand. A little twitch of the gloves as the dog passed the particular letter wanted was the cue. The well trained animal took in the slightest stir of the gloves with the corner of his eye. This dog even played a game of cards—and won. A hundred and one variations might be made on the same trick.

I have read since in an American newspaper of a Tennessee

pig that acquitted itself creditably in practically the same *rôle*. Doubtless, if the report were true, the porker had swallowed an equal amount of learning.

The collie was without doubt a good, clever one. As member of the Irish Collie Club I have for years past taken a fancier's interest in this particular breed, and I have observed every degree of intelligence, from the brute that could scarcely be taught to bark at a cow—oftenest with a pedigree as long as your arm—to the affectionate animal that could guess almost your thoughts and your passing temper, and was always in perfect sympathy with your moods. The best of these, however, falls far short of a good Irish water spaniel. From my experience, I may be allowed to say in passing that no breed is so teachable—has such brain-power, if you like—as the latter, once he has reached the age of nine or ten months. As puppies I found them rather stupid.

Performances similar to that of the Royal Aquarium collie are not very rare. There are, indeed, some other ingenious stage devices by which a dog can be taught to spell—every word in the dictionary if you are so foolish as to let it be known—and to converse, so to speak, in Russian as readily as in English, but the devices are rather worked out.

Usually such show dogs modestly protest before the audience (through their trainers) their inability to do more with certainty than spell correctly words of three letters, and when pushed they get perplexed and make mistakes. This, for them, is sound policy. It is only when they grow too bold and set up as "thinkers" that they are found out. My American trainer, with Yankee shrewdness, used to claim for his dark bay charge that when he had totted up a row of figures he should be reminded of the number to be carried on to the next column. This was fair enough. It, too, served to baffle the over-canny. That the arithmetician's education could never overstep that was just the puzzle they fastened on and worried over. I wonder what the German professors, good, easy men, would have said had they seen, as I did, Mahomet figure out a sum with his tail to the board!

I may be permitted to add that about the same time I interviewed the ape famous for counting, "Sally" by name, in the London Zoological Gardens, and I was in no way impressed by her intelligence. After what I have written it is not hard to suggest two or three ways by which the oracle could have been worked. I saw her count her straws for the keeper alone, and that gentleman appeared to me none too tolerant of questions or of interference.

I am prepared for believing, however, that counting is not beyond the scope of an animal's powers. It is said that Scotch shepherds count their flocks of sheep in this wise: they drive them through a gap, and the faithful collie ticks off by a bark every score as it passes through.

It is not of late alone that clever horses have come to the front. I happen to possess a MS. diary written by a co. Leitrim man in 1658 and 1659. In the first of these years the writer, James Reynolds, accompanied to London his uncle, Sir James Ware, Auditor-General of Ireland, and famous as an antiquary. Among the sights of the metropolis he records that he saw a "Nagg" which could count, answer questions, and fire off a small cannon.

There are undoubtedly degrees of intelligence within limits in all mere animals. They are particularly observable in the dog and horse—the most highly developed in this respect of all our animal friends. As every jarvey knows, each horse has a character of its own and mental powers all its own. The same is true of our canine subordinates. A neighbour of mine has a cat which climbs up the door-post and opens the latch with her paw when she wants to enter the house. This for a cat is, I think, more wonderful than are all the performances of the Berlin "thinking horse" for a steed. It is a trick, indeed, I have seen taught two or three dogs. But the cat has had no training. She owes her cleverness solely, I am assured, to her own powers of observation.

I am open to conviction, but I am greatly afraid the "German representative committee," including the "professor of the Physiological Institute of the Berlin University," that have reported, according to the daily Press, on "Clever Hans" have written themselves down as at least not ungullible. JOSEPH MEEHAN.

Creevelea, co. Leitrim.

Misuse of Words and Phrases.

In your issue of October 13 attention was directed in the letter column to the misuse of language by English scientific writers. Since the subject of the indictment is one of importance, and since the criticism is in my opinion well founded, I am writing to support it.

There seems to be a tendency growing among writers on scientific subjects, both in pure and applied science, to modify the English language to such an extent as to give rise to no small anxiety with respect to its future state in scientific literature.

Even if language is plastic, its plasticity is limited. Since science is based upon accuracy, the communication of scientific thought should be accurate. Yet in a large percentage of scientific publications in the English language sentences that are grammatically ambiguous occur frequently, and not seldom such as have no meaning. The sense intended may be, indeed, derived from them, either through study of the context, or through exertion of one's scientific instinct; but it is surely just to demand that the unnecessary labour of a cryptogrammic research be not inflicted on the reader. Viewed in its crudest aspect, such misuse of language is an act of discourtesy to the reader; so legitimate resentment should provoke no surprise in the author.

It is common in a certain class of publications to meet files of nouns marching through the paragraphs. Although this may at times indicate a well grounded derivation of adjectives, yet it is frequently unnecessary, either since a suitable adjective exists, or since a prepositional or adverbial phrase conveys the meaning exactly.

Various other parts of speech are frequently misused.

There is no need for fine style in scientific literature; but good style is obligatory, because it is an essential concomitant of the accurate expression of clear thought.

October 17. F. ESCOMBE.

SCIENCE IN SPORT.[1]

THE late Prof. Tait was probably the first to bring scientific principles and methods of experiment to bear upon the mystery of the flight of a golf ball. Newton, in a pregnant note on the deflection of a tennis ball in air, gave the foundation principle, which curiously enough both Euler and Poisson rejected as of no account. Robins and (later) Magnus experimented on the effect, but it was left to Tait to work out the problem in detail. His papers on the rotating spherical projectile virtually form a new chapter in the dynamics of rotation. In these papers, and elsewhere in more popular form (*e.g.* in NATURE, vol. xlii. p. 420, 1890), he lays down clearly the conditions which must be fulfilled if a man is to drive a far and straight ball. Slicing, pulling, topping, are all completely explained along the lines of Newton's remark, numerical tests are supplied, and various possible curves of flight are calculated out and drawn.

Tait showed how the ball must be started if it is to finish aright. The difficulty the ordinary golfer experiences is to give the proper start. This is *his* problem; and the mode of solution is as varied as the temperament of the player. There is, in fact, a continuous gradation of style and effort from the simple minded golfer whose one aim is to hit the ball to the nervous and pathetically anxious one who looks to every detail of grip and stance as a *sine quâ non* to perfection. There must, however, be a best way for every individual, and in discovering this the aspirant no doubt should be guided by scientific principles.

This is, perhaps, the most important practical standpoint from which to view Mr. George W. Beldam's interesting and beautiful book, "Great Golfers. Their

[1] "Great Golfers. Their Methods at a Glance." By George W. Beldam. Pp. xxiv+481. (London: Macmillan and Co., Ltd., 1904.) Price 12*s.* 6*d.* net.

"The Art of Putting." By Walter J. Travis and Jack White. Edited and Illustrated by G. W. Beldam. Pp. 32. (London: Macmillan and Co., Ltd.). Price 1*s.* net.

Methods at a Glance." It is doubtful if methods essentially kinetic can be effectually disclosed by glances at a few critical positions statically pictured by instantaneous photography. Nevertheless, Mr. Beldam's idea is a good one, and has been carried out with great manipulative skill. The idea is to obtain accurate pictures of some of our best golfers, professional and amateur, in their characteristic poses as they address and play a ball, and to be able from those pictures to deduce important conclusions. By a simple system of rectangular coordinates, with origin at the ball and one axis in the desired direction of flight, the positions of the player's feet are accurately shown. The grip of the club, the poise of the body at different stages of the stroke, and the position of the arms at

Fig. 1.—Golf Ball leaving an Iron Club after impact. From "Great Golfers."

the top of the swing, are all recorded as the player is taking his normal stroke. The descriptive discussion is given by the four professionals Vardon, Taylor, Herd, and Braid in regard to their own pictures, and by Mr. Hilton in regard to the pictures of the amateurs.

It is evident that all the motions of the body, head, arms, thighs, legs and feet are governed by the way the club is raised to the top of the swing and brought down again to the finish of the stroke. Keep the head steady—best done by keeping the eye on the ball—keep down the right elbow, and practice will do the rest. The backward swing of the club and arms makes the body rotate easily about a vertical axis, and produces naturally the characteristic bending of the left knee (in a right handed player). It is interesting by measurements on the successive positions of the player as he (1) addresses the ball, and (2) reaches the top of the swing, to determine how much, if at all, the head rises. In this respect, for example, Vardon and Taylor differ decidedly. Exactly the instant during the swing at which the left leg begins to support the greater part of the weight of the body is not clearly brought out.

There are of course great difficulties, even with an exposure of only one-thousandth of a second, in catching the player at the very instant the ball is struck, or just before the impact takes place. Out of the 268 "action photographs" three only can be accepted as giving any information regarding this critical moment. It is just here, in fact, that a word of criticism might be offered. From a scientific point of view the numerous pictures representing the *finish* of the stroke are comparatively worthless—beautiful and striking and "characteristic" though they are as showing the pose of an athlete who has just done the deed. We could gladly have dispensed with half a hundred of these for the sake of even an extra half dozen like Taylor's Nos. xxi. and xxviii. Unfortunately in these particular pictures the ground is not chalked off with the pattern of six-inch squares, so that we can only roughly estimate the position of the ball when it was struck.

In plate xxviii. (here reproduced) the blurred image of the moving golf club and of the still more rapidly moving ball are finely brought out, while the player, with the exception of the right arm and hands, is as steady as a rock. We may roughly estimate the velocity of the ball to be nearly $2\frac{1}{2}$ times that of the club. The exposure is stated to have been 1/1000 of a second. The blurred image of the club head may be estimated at not less than 4 inches broad, giving a velocity of about 370 feet per second for the club head *after* impact. This would mean fully 900 feet per second for the ball. Tait gave a great deal of attention to this point, and concluded that a well driven ball rarely left the ground with a greater velocity than 350 feet or 400 feet per second. The discrepancy is great, and points to some fundamental error either in Tait's mode of measurement of the velocity or in Mr. Beldam's mode of measurement of the exposure. The photograph tells its own tale, and is above criticism; but we have no precise account of how the times of exposure were estimated. A few more pictures of the kind just discussed, showing the *motion* immediately before impact, at impact, and immediately after, with different clubs and different balls, would give some really important information as to velocities and coefficients of restitution.

Every golfer knows the value of steady and accurate putting, and how curiously variable is his "form" in this respect. Mr. Beldam's photographs bring out the very familiar fact that stance and pose are of comparative insignificance. In a small pamphlet on "The Art of Putting" Mr. Beldam has notably supplemented his volume. Here we have six photographs illustrating the style of Mr. Travis, Amateur Champion of 1904, and fourteen of Jack White, the Open Champion. Each discusses his own methods. The professional's account is particularly instructive, and touches on many difficult points, such as putting uphill or downhill or on a side slope; but here, as in billiards, a knowledge of how to do is one thing, and the power to do quite another.

It is certain that as an exponent of good method no book on golf can compare with "Great Golfers"; and we have indicated above that Mr. Beldam's photographs have a scientific value quite apart from the "science" and art of the royal and ancient game.

C. G. K.

A GERMAN'S DESCRIPTION OF ITALY.[1]

THE volume before us might not inappropriately be called an "Encyclopædia of Italy." It deals in the first eight chapters with the general geographical and geological features of the country, its shape, its surrounding seas, the relief of its principal mountain ranges, its geological construction, its climate, hydrography, fauna and flora. The next seven chapters deal generally with the Italian people and their life, the subject being classified under the various headings of population, history, products, commerce and trade, political institutions, religion, art, language and science. The sixteenth chapter, which is devoted to "Topography," extends over more than 120 pages; in it the various districts of Italy are taken in turn, and their principal towns, antiquities, rivers, and mountains are dealt with in some detail.

To write a treatise of this character is no easy task, if the book is to convey anything like an adequate account of the country. To test the completeness with which the author has accomplished his work we have consulted the book under various headings selected at random, and in few cases have we found any point of real importance or interest missing. The account given of the Italian lakes is very thorough, and contains details of their principal features, as well as information of a statistical character and several illustrations. Still greater interest attaches to the sections dealing with volcanic action and earthquakes, in which excellent illustrations are given of Vesuvius in its various aspects, the Solfatara, Etna, and the Lipari islands; and the references to the changes of relative level of the land and sea at the Temple of Serapis and the Blue Grotto may be cited. The chapter on "Plants and Animals" is not, perhaps, so fully treated as other parts of the book, and also there are a few slight inaccuracies, probably resulting from the difficulty of finding exact equivalents for the German words in the English translation. Whether the name "manna" is correctly applied to the sap of the Calabrian flowering ashes (p. 114) is a point on which we are not competent to pass judgment; it should, however, be mentioned that "manna of the desert" has been considered to be a lichen. When the fruit of the olive is described as green, brown, or red (p. 116) the latter term hardly appears suitable. On p. 120 the name "gorse" is applied to *Genista hispanica*, a plant which, indeed, often takes the place of our English Ulex in Italy, but can hardly be properly called "gorse."

Again, it is doubtless probable, as stated on p. 122, that fishermen often apply the term "frutta di mare" to shell fish generally, but correctly speaking this is the name of the edible echinus. The large cuttlefish or octopus is too characteristic an article of food at Naples to be omitted from the list, and the Agoni and large trout of the Lombardy lakes ought to receive some mention.

FIG. 1. Arco naturale in Capri. From Prof. Deecke's "Italy."

We pass on to the chapter on "Political Institutions," where it is particularly interesting to see what a German thinks of the slipshod way things are done in a free country like Italy. Prof. Deecke strongly condemns the abuses resulting from political liberty and local government as practised in that country; for example, he says (p. 253):—

"The successful working of a liberal constitution and self government presupposes a conscientiousness and disinterestedness among the officials. There is little of these qualities to be seen in Italy. The honorary posts are looked upon as a kind of milch-

[1] "Italy, a Popular Account of the Country, its People, and its Institutions (including Malta and Sardinia)." By Prof. W. Deecke. Translated by H. A. Nesbitt, M.A. Pp. xii+485; illustrated. (London: Swan Sonnenschein and Co., Ltd.; New York: The Macmillan Co., 1904.)

cow which must be milked with all one's force when one is at the helm. In addition to this there is the want of scruple as regards public money, which, according to a very general view, exists in order to be appropriated to any plausible pretext or to be secured for one's family or friends. . . ."

The author also condemns the wasteful system which exists in municipal bodies of embarking on costly enterprises, which are discontinued after the next municipal election when another party comes into power. In this way the money of the ratepayers is squandered away with no return. In regard to the confiscation of the monasteries, the following sentences may be quoted:—

"These regulations, however, have been applied in the half and half manner characteristic of Italy." "The vast ecclesiastical possessions seized by the State were sold or squandered in the course of a few years." "Thus the enormous source of income which might have proved a blessing to thousands and created a small class of landed proprietors has failed to bestow the expected benefit on the country."

On p. 279 we are told, "The Building Societies are almost a public calamity." "The hideous new quarter near the railway station at Naples, on the Vomero at the same town, and in the Campus Martius at Rome are the best proofs of the results of carrying on business in this manner."

Speaking of universities, Prof. Deecke makes the following remarks, which are equally applicable to our English system:—"There is another difference as compared with Germany, namely, that the Professor appointed to hold a course of lectures is not allowed to take a general survey of his subject or to handle it fully, but has to dispose of a prescribed section of the subject in the three hours a week, so that at the final examination questions can be set within this narrow circle. The instruction given at the Universities naturally suffers, and still more the scientific training of the students, which can only be described as unsatisfactory."

The chapter on art, language and science contains a list of the principal learned academies of Italy.

In connection with music, the author remarks:—"The music of Wagner, poor in melody and difficult to understand, has not become naturalised in Italy."

As illustrating more fully the wide and varied range of the subjects treated, we may instance the statement that there are ten times as many murders in Italy as in Germany, the regulations limiting the number of barrel-organs in Naples, the number of pedlars, the method of smelting sulphur, the statistics of Italians abroad, observations of terrestrial magnetism, the superstition according to which cats' tails are docked, a portrait of Garibaldi and a plan of the harbour of Genoa, photographs of Roman cattle, and descriptions of Italian cheese.

The section on topography might be very well studied by anyone contemplating a tour in Italy. It gives an excellent account of the features worth noticing in different districts, and it includes the Maltese group as well. It is well illustrated. But for that matter the whole book would well repay reading before or after visiting Italy. The average tourist contents himself when visiting a new country with seeing the principal churches and picture galleries, usually conducted by a guide, but to visit a country properly a wider survey should be taken, and a book like the present consulted. To the writer this book brings back the most pleasant reminiscences of bygone travels in Italy; to the reader who has stayed at home it presents as graphic a picture as any book can present of everything that is Italian.

G. H. BRYAN.

DISEASE-PROOF POTATOES?

THE recently established National Potato Society has as one of its many objects the discovery of a "disease-proof" potato. Even if it only succeeds in throwing some light on the relative immunity of some varieties, and on the causes of that comparative exemption, it will do some good. Next to wheat, there is no crop more important in this country, and whilst wheat-growing seems to be getting more and more unprofitable, the culture of potatoes is extending so much that it is evident that the growers must find some good reason for the increased production. The enormous importations from Germany, Holland, and other countries should serve as a stimulus to our farmers, for it is obvious that, excepting in the comparative cheapness of labour, those countries possess no special advantages over our own in the matter of potato-growing.

In dealing with the question of the potato disease, by which we mean the rotting caused by the fungus *Phytopthora infestans*, there are two principal subjects of inquiry: first, the life-history of the fungus; second, the "constitution," if we may use so vague a term, of the potato plant.

Neither of these subjects can be thoroughly investigated by the average potato grower. All important as they are, they lie outside the range of his capabilities. It is to our research stations or to individual experimenters that we must look for guidance. Even now the life-history of the fungus is imperfectly known. We do not know *for certain* what becomes of it in the winter, nor why it suddenly bursts into activity under certain atmospheric conditions. We do not know for certain whether it can pass any portion of its life on some other plant under another guise. We do not know for certain if a resting spore is formed, and our knowledge of the mycelium during the winter is, for the most part, conjectural rather than real. Here, then, are subjects for inquiry at once of the deepest physiological importance and of the greatest practical value.

As to the so-called disease-resisting varieties, also, further information is wanted, and this the practical man might supply. A visitor to the recent display of potatoes at the Crystal Palace, seeing the innumerable varieties there exhibited, might well wonder whether they all "supplied a want," and it was consolatory to the casual observer to hear even experts acknowledge the impossibility in some cases of discriminating one variety from another by the tubers alone. Had it been possible to show the haulms, the foliage, and the flowers and fruits with the tubers, as was, in fact, done in one or two cases, some points of distinction might have been forthcoming.

But although there is often a close resemblance between the tubers of one variety and those of another, and although it frequently happens that tubers of quite different shapes may occur on the same plant, yet it does not appear, from our present knowledge, that this similarity on the one hand, or this diversity on the other, is associated with any structural change which shall indicate either immunity from disease or increased susceptibility to its attacks. In the case of potatoes, certain varieties, like Sutton's Discovery, are unusually robust, producing haulms almost woody in their character, and these are found to be less susceptible to disease than are others of softer, more juicy consistence, which are more easily penetrated by the fungus hyphæ. Differences of this character, dependent on increased vigour of growth, are recognised by the growers, but we are not aware that microscopists have as yet made any researches into the structure of the potato foliage with special reference to its immunity from, or susceptibility to, disease. It

is certainly desirable that such investigations should be made, although, in view of the investigations on various species of Bromus and their liability to disease made by Marshall Ward, Salmon, and others, it is doubtful whether mere microscopic investigation of the internal economy will furnish more valuable results than comparative macroscopical study of the haulm and foliage. Great physiological differences may, on the one hand, exist in conjunction with uniformity of structure, and, on the other hand, great external differences may exist without appreciable physiological diversity.

Some improved method of investigating the nature and construction of the protoplasm seems to be required, and when this is obtained our knowledge of the relation of function to structure will of necessity be much enhanced. At present the three most efficient means of preventing or combating the disease are the production of immune varieties, the use of sulphate of copper in the form of Bordeaux mixture, and the adoption of "high-moulding," by means of which access of the fungus spores to the tubers is at least in part prevented.

NOTES.

We regret to announce that Dr. Selim Lemström died at Helsingfors on October 2, in the sixty-sixth year of his age. Dr. Lemström devoted much attention to experimental investigations on the uses of electricity in stimulating the growth of cereals, vegetables, and other plants.

As already noted in these columns, a distinguished party of French physicians and surgeons has during the past week paid a visit to London in order to become acquainted with our medical schools and hospitals and to study their methods and administration. About 150 gentlemen availed themselves of the opportunity, amongst others M. Lucas Championnière, Prof. Poirier, Prof. Marie, Prof. Netter, M. Louis Martin, M. Huchard, M. Triboulet, president of the French committee, and Dr. Sillonville, secretary. An English committee, with Sir W. Broadbent as president, Sir T. Barlow and Dr. Dundas Grant as treasurers, and Drs. Dawson Williams and Jobson Horne as secretaries, made arrangements for the reception and entertainment of the visitors. Visits were paid to the hospitals, general and special, the physiological laboratories of the University of London, University and King's Colleges, the Lister Institute, the Royal College of Surgeons, cancer research laboratories, the County Council laboratories at Claybury, the London School of Tropical Medicine, and to the Islington Infirmary. The visitors expressed themselves as specially pleased with the order and neatness, the decorations, &c., and the home-like comfort of the wards of our hospitals. During the visit they were the guests of the editors of the *Lancet*, Dr. and Mrs. Dundas Grant, the Dean of the Faculty of Medicine of the University of London and Mrs. Butlin, and on Wednesday evening, October 12, they were entertained at a farewell banquet at the Hotel Cecil, at which Sir W. Broadbent presided. The chairman, in proposing the health of the King, alluded to His Majesty's interest in hospitals and medical work. The other toasts were the President of the French Republic, and "Welcome and *Au revoir*," proposed by the chairman; our guests, by Dr. George Ogilvie, responded to by M. Championnière and Prof. Huchard; and the Faculty of Medicine of Paris, by Dr. Pye-Smith, responded to by Prof. Poirier, Prof. Chauffard, and M. Triboulet. The visit has been a great success, and should prove a benefit to both nations.

REUTER reports that the commander of the *Neptune* Scientific Research Expedition to Hudson Bay and the northern waters has returned to Ottawa with several interesting mementoes of the Franklin Expedition.

MR. H. MARTIN LEAKE, of Christ's College, Cambridge, has been appointed economic botanist to the Government of the United Provinces, India, and proceeds at once to the botanic gardens, Saharanpur, N.W.P.

A CONFERENCE of members of the Museums Association and others interested will be held at Warrington on Saturday afternoon, October 29, for the purpose of discussing subjects of common interest to those concerned in the work of museums, art galleries, and kindred institutions.

THE *Electrician* announces that a congress for the purpose of discussing the production and application of Röntgen rays will be held in Berlin on April 30, 1905. The occasion is the tenth anniversary of the discovery, and Prof. Röntgen will be present as the guest of honour.

A COURSE of twelve Swiney lectures on geology will be commenced by Dr. J. S. Flett at the Victoria and Albert Museum, South Kensington, on Monday, November 7. The subject of the lectures will be "Geology—the Record and its Interpretation." Admission to the course is free.

THE King has consented to give his patronage to the Sanitary Institute, which is carrying on a large work in teaching and examining in hygiene and sanitary science, both in the United Kingdom and in other parts of the Empire.

AT the opening meeting of the new session of the Royal Geographical Society, to be held at the Albert Hall on November 7, Captain Robert F. Scott will deal with the leading features of the National Antarctic Expedition. At subsequent meetings Lieut. Royds will deal with the meteorology of the expedition, Mr. Ferrar with the geology, Dr. Wilson with the zoology, and Mr. Bernacchi with the terrestrial magnetism.

THE inaugural meeting of the Association of Economic Biologists will be held at the rooms of the Linnean Society, Burlington House, on Tuesday, November 8, at 3 p.m. All who signify to Mr. W. E. Collinge, the University, Birmingham, their intention of becoming members before October 31 will constitute the list of original members.

WE learn from a note in the Isle of Man *Times* that within the last few days the large pond at the biological station and fish hatchery, Port Erin, has been in great part emptied for the purpose of examining the condition of the stock of fish of spawning size and the state of the bottom of the pond. Out of 180 large adult plaice which had been, at various times since the autumn of 1903, deposited therein, 168 were safely transferred to the lower supply tank. The condition of these fish was all that could be desired; they were thick, strong, and well fed; many were very large. There were also very many young plaice which were hatched at the station last Easter from parents in captivity—the large fish alluded to, and so have been under artificial conditions—made as natural as possible—during the whole of their existence. These young plaice, four to five months old, were from one to four inches long (the large variation in size is noteworthy), active, and well nourished. Some hundreds were picked out for experiment in rearing in small wooden tanks lately fitted up. There were also found some shrimps, some young of the cod tribe, and a small shoal of young herring (whitebait size). All these must have passed through the pumps from the sea, probably in a larval condition. The young plaice examined were found to be feeding mainly on Copepoda.

It is announced in the *Times* that the Secretary of State for India has appointed an expert committee to assist in and supervise the preparation of an abridged and revised edition of the "Dictionary of Indian Economic Products," by Sir George Watt, the editor of the original work, which was issued in seven octavo volumes, with index, between 1889 and 1893. The new edition will be compressed into two volumes, and care will be taken to give the latest figures and information available in respect to the products described, and to their commercial development. Special facilities have been afforded for Sir George Watt to carry on the work of revision at Kew, and Sir W. Thiselton-Dyer, director of the Royal Botanic Gardens there, is chairman of the committee, the other members being Mr. T. W. Holderness, secretary of the Revenue and Statistics Department, India Office; Prof. Wyndham R. Dunstan, director of the Imperial Institute; and Mr. J. S. Gamble, late of the Indian Forest Department.

A second conference of local authorities, owners of foreshore, and others interested in the defence of the coast against the encroachment of the sea in the counties of Norfolk and Suffolk was held at the Guildhall, Norwich, on October 15, for the purpose of considering the report of the committee appointed by the previous conference. Dr. H. B. Walker, mayor of Lowestoft, presided. The report stated that the Government had been asked to adopt promptly such measures as would preserve the sea coasts from waste and provide a more equitable adjustment of the financial burden which now pressed exclusively upon the immediate frontagers. Mr. Nicholson (town clerk of Lowestoft) said that the Board of Trade had declined to appoint an engineer to make inquiries. A resolution was adopted in favour of communicating with other authorities in Great Britain whose districts abut upon and are liable to erosion by the sea, and with members of Parliament representing such districts, to ascertain how far they would cooperate in an application to the Government to accede to the recommendations contained in the report.

It is reported that the Antarctic relief ship *Morning* has brought home a considerable collection of natural history specimens which will supplement those obtained by the *Discovery*. A considerable amount of dredging was accomplished on the *Morning*, so that the collection consists chiefly of marine invertebrates. As she is an Admiralty ship, all the specimens collected will doubtless be handed over to the British (Natural History) Museum, where the *Discovery* collections have already been received.

In the *Irish Naturalist* for October Mr. D. R. P. Beresford records the discovery in Ireland of a second nest of the Continental wasp, *Vespa rufa austriaca*; the first was found in 1902.

In his report for 1903 (issued in the *Circulars* of the Royal Botanic Garden) the Government entomologist for Ceylon refers with satisfaction to the appreciation of the efforts of his department to aid cultivators in freeing their plantations from the attacks of noxious insects. The report deals largely with those affecting the tea-plant.

The contents of part i. of the second volume of the quarterly issue of the *Smithsonian Miscellaneous Collections* include a continuation of Messrs. Ulrich and Bassler's revision of the Palæozoic Bryozoa; a paper by Miss E. Wood on Devonian crinoids, with descriptions of new genera and species; and a review of the triton and frog-shells by Mr. W. H. Dall, in which several new subgeneric names are proposed.

The Society for the Protection of Birds has issued as a leaflet an abbreviation of an admirable article by Mr. W. P. Pycraft on the manufacture and sale of the so-called "osprey" plumes, which recently appeared in *Knowledge and Scientific News*. In the October number of *Bird Notes and News* the society directs attention to the marked decrease in the number of swallows visiting this country and the Continent during the last few years. The scarcity is attributed to the capture of these birds for their plumage and for the table, and it is suggested that extensive netting must take place at both migrations, though where this occurs has not been ascertained.

According to the report of the Manchester Museum for 1903–4, it appears that the most important acquisition received by the museum during the period under review is the Cosmo Melville herbarium, which was presented by the chairman of the committee. The contents of this collection, stated to be the only private one of which the limits extend beyond the Palæarctic region, are estimated to number more than 40,000 species. It is incidentally mentioned that the skin of Napoleon's Arab charger "Marengo," which is reported to have been lately discovered in a cellar at the Louvre, was formerly in the Manchester Museum. The skeleton is, we believe, in the United Service Museum.

The latest of the series of handbooks to the contents of the Horniman Museum at Forest Hill, issued by the London County Council, relates to the fresh-water aquariums and vivariums. In these receptacles are exhibited a large number of the common British invertebrates, together with a selection of fishes, reptiles, and amphibians. The descriptions of the various species grouped are written, as a rule, in language which can be well understood by the ordinary reader; we may point out, however, that if it is necessary to explain a term like "Porifera" it is equally necessary to do the same in the case of one like "unicellular" (p. 4), the meaning of which, we venture to think, will not be comprehended by 1 per cent. of the visitors to the museum.

In the October issue of the *Journal of Conchology* Mr. A. J. Jukes-Browne refers to the dissatisfaction which exists among many naturalists on account of the sweeping changes proposed in zoological nomenclature by a strict and slavish adherence to the rule of priority. He points out that no less than a dozen familiar names of molluscan genera would have to be changed if those used in a certain obscure work be admitted. The evil is a very real one, and we refer to two points in connection with it. In the first place we notice that in the main only systematic naturalists adopt the proposed changes, anatomists, physiologists, &c., adhering to the old names; this at once introduces a dual system of nomenclature, which is much to be deprecated. Secondly, it may be admitted that to specialists the changes in nomenclature in their own particular groups are not very serious, as they ought to be able to keep abreast of them; but to "all-round" naturalists such changes are very serious indeed. An authoritative conference on the subject is urgently needed.

In the *Revue générale des Sciences* (September 30) M. Ernest Fourneau describes the chemical constitution of the chief local anæsthetics, such as cocaine, eucaine, &c., and discusses the nature of the chemical groups and their arrangement on which analgesic action seems to depend.

We have received Mr. W. Martindale's price list of drugs, chemicals, surgical instruments, &c. The catalogue

of drugs, chemicals, and microscopical stains seems to be very complete, and we note that several pages are devoted to X-ray apparatus.

IN the *Bulletin* of the Johns Hopkins Hospital for September (xv., No. 162) Dr. Howard Kelly describes an ingenious instrument, the piezometer, for measuring degrees of resistance, *e.g.* rigidity of the abdominal wall or the limits of a tumour. Reviews of books and some medical and medico-historical articles complete this excellent number.

IN the *Bulletin international de l'Académie des Sciences de Cracovie* (No. 7, July, 1904) M. Nitsch describes some experiments on rabies in rabbits, and states that the earliest symptoms of infection are movement of the jaws and grinding of the teeth. M. Maziarski discusses the relation of the nucleus to the cytoplasm, and M. Kowalewski describes a new species of tape-worm, *Tatria biremis*, found by him in the intestine of *Podiceps auritus*.

THE Liverpool School of Tropical Medicine has issued an important series of reports on trypanosomiasis by Drs. Dutton, Todd, and Christy, which seem to establish conclusively that sleeping sickness is trypanosomiasis, although there are severe and even fatal cases of the latter in which the somnolence is not observed. In one of the expeditions of the school a blood-sucking larva of nocturnal habits was found to be abundant in many districts of the Congo.

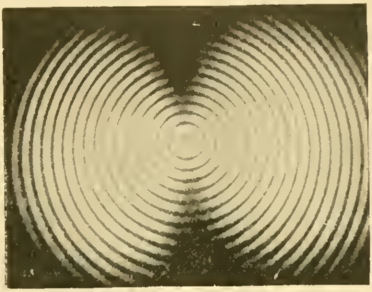
IN the October number of the *Journal of Hygiene* (vol. iv., No. 4) Dr. Boycott discusses the diagnosis of ankylostoma infection with special reference to the examination of the blood, Dr. Todd describes experiments on the preparation of dysenteric toxin and antitoxin, and Dr. Castellani details researches on the etiology of dysentery in Ceylon. The Swedish Antarctic Expedition forms the subject of an article by Dr. Ekelof, the medical member of the expedition, in which he discusses its medical aspects.

AN interesting report by Drs. Jobling and Woolley on Texas fever of cattle in the Philippine Islands is published by the Bureau of Government Laboratories, Manila (1904, No. 14). Some imported American cattle, after inoculation for rinderpest with the blood of native animals, rapidly died with all the symptoms of Texas fever. Investigation proved that Texas fever was endemic among the native cattle, which, however, had acquired an immunity and suffered but little from the disease. The species of tick in the islands was found by Mr. Banks, Government entomologist, to be the Australian variety (*Boophilus australis*).

THE Meteorological Department of the Transvaal (Mr. R. T. A. Innes, director) has issued its administration report for the year ending June 30, 1904. Such of the instruments ordered from this country as had then arrived there had been distributed, and continuous records of some elements would be available from July 1, 1904. Rain gauges were considered to be the most important for immediate erection, and nearly 200 voluntary observers had been supplied with these instruments. All the observations made in the colony will be published in an annual volume. Telegraphic or telephonic weather reports are received daily from twenty-nine stations, and telegrams exchanged with other colonies. The staff is at present much too small for the important work in hand.

PART iii. of the new monthly journal *Le Radium* contains a summary by Prof. Turpain of the present methods of producing high frequency currents, an account by M. M. Moulin of the *n*-rays and the methods used in their study, and an article by Dr. A. Darier on the physiological effects of the radiations from radio-active substances.

BY slightly modifying Pocklington's method of observation, M. H. Dufet has succeeded in making measurements of the rotatory power of biaxial crystals in the direction of the optic axes. The results are described in the October part of the *Journal de Physique*. With the apparatus employed it becomes possible to make observations with much thicker plates than have hitherto been used, and in this way to observe a large number of turns of the isochromatic spirals instead of only their commencement. The paper is illustrated by photographs, and the accompanying figure represents the rings and spirals for the violet mercury



line λ 4358 in the case of the slightly birefringent substance rhamnose. The plate used was cut normally to the stronger axis, and had a thickness of 0·27 mm. The rotation along the symmetrical optic axes of crystalline *d*-tartaric acid has a value of $-114°$ per cm.; it is a striking fact that the rotatory dispersion of solid tartaric acid is normal seeing that in aqueous solution the dextro-rotation of the acid undergoes very anomalous changes with variation of the wave-length. All the biaxial substances studied which were found to show rotatory polarisation in the solid state are capable of existing in enantiomorphous hemihedral forms.

AN interesting paper by T. Godlewski on the dissociation of electrolytes in alcoholic solution appears in the *Bulletin* of the Cracow Academy of Sciences (1904, No. 6). The well known dilution law of Ostwald is satisfied by all the eight acids which have been examined. The order in which the acids appear, when arranged according to the magnitude of their electrolytic dissociation constants, is different from that which holds for aqueous solutions of the acids.

A VERY sensitive method of testing for minute traces of gold is described by J. Donau in the *Sitzungsberichte* of the Vienna Academy of Sciences (vol. cxiii. p. 180). A silk or woollen fibre, previously treated with a solution of tannin or a solution containing pyrogallol and stannous chloride, is immersed in the acidified solution to be examined for gold. If present, the latter is precipitated in the colloidal form on the fibre, and imparts to it a red coloration which is observed by examining the fibre under the microscope. With a silk fibre, mordanted with pyrogallol and stannous chloride, 2×10^{-9} gram of gold can thus be detected.

SOME interesting observations on aqueous solutions of magnesium oxalate are communicated by Kohlrausch and Mylius in the *Sitzungsberichte* of the Prussian Academy of Sciences (1904, p. 1223). By dissolving magnesium hydroxide in aqueous oxalic acid, it is possible to obtain

solutions which contain three hundred times as much magnesium oxalate as that present in the saturated solution of the hydrated salt. Electrical measurements show that the equivalent conductivity decreases at an abnormally high rate as the concentration increases. This and other phenomena furnish strong evidence in support of the view that polymerised molecules are present in the solution in considerable proportion.

A SECOND edition of Mr. Borchardt's "Arithmetical Examples," to which twenty-four pages of new exercises, oral and otherwise, have been added, has been published by Messrs. Rivingtons.

A "GEOMETRICAL Political Economy," by Mr. H. Cunynghame, C.B., is about to be published by the Oxford University Press. The work is an elementary treatise on the method of explaining some of the theories of pure economic science by means of diagrams.

THE October issue of the *Popular Science Monthly* is devoted entirely to the Cambridge meeting of the British Association. Dr. Pritchett, president of the Massachusetts Institute of Technology, contributes "A Traveller's View of the British Association Meeting," and in addition are included the presidential addresses of the Prime Minister, Prof. Horace Lamb, Mr. W. Bateson, Mr. Francis Darwin, Mr. Henry Balfour, Mr. Douglas Freshfield, Prof. C. S. Sherrington, and the Hon. Charles A. Parsons.

OUR ASTRONOMICAL COLUMN.

ENCKE'S COMET.—The absence of further observations of Encke's comet has caused some doubt to be expressed as to the correctness of Herr Kopff's conclusion regarding the identity of the object which he obtained on his photograph of September 11.

In the *Astronomische Nachrichten*, No. 3970, the same observer states that he has obtained confirmatory evidence which places the identity beyond doubt, although the comet is still extremely faint and diffuse. On a photograph exposed on September 17, at 13h. 29.2m. (Heidelberg M.T.), the same object appeared in the following position:—

$$\text{R.A.} = 1\text{h. } 40{\cdot}6\text{m., dec.} = +26^\circ\ 14'.$$

On comparing this position, and the one determined in the first observation (September 11), with the interpolated values obtained from the ephemeris published by MM. Ocoulitsch and Kaminsky, it is seen that the ephemeris requires the following approximate corrections:—

$$-0.7\text{m. and } -6'{\cdot}0.$$

Herr P. Gotz, of Heidelberg, was unable to find the comet on September 6 with a 6-inch telescope.

STRUCTURE OF THE OXYGEN BANDS IN THE SOLAR SPECTRUM.—In the September number of the *Astrophysical Journal* Mr. O. C. Lester, of the Sloane Physical Laboratory, Yale University, discusses the results recently obtained by him in a research as to the nature of the oxygen bands in the solar spectrum, of which the B group is a typical example.

The purpose of the research was to investigate the relations existing between the lines of each band and between the several bands, including in the latter two bands above a which do not appear to have been discussed previously.

The results may be summarised as follows:—(1) More accurate measures of the wave-lengths of the lines in groups A, B, and a have been made, the a' band has been measured for the first time, and a new group (a'') at λ 5377.2 has been discovered and its lines measured. (2) It has been shown that the oxygen absorption spectrum consists of two distinct series of bands, instead of one, which occur in pairs similarly to the series of lines in a band. (3) Deslandre's first law concerning the distribution of lines in a spectral band, viz. $N = a + bn^2$ (where N = the vibration frequency number, a and b are constants, and n takes on all integral values from 0 to n), is shown to be inadequate to represent the line series of the several bands. A modification of this formula suggested by Mr. Lester is

$$N = a + kn + c^{-1}n^2,$$

and this represents the series within the limits of observational errors; c and k are constants which are different for each series, although the differences are but small.

RECURRENT MARKINGS ON JUPITER.—From the inspection of several thousand drawings of Jupiter made during the last half-century, Mr. Denning has arrived at the conclusion that "features exhibiting various peculiarities of appearance and rates of motion are common to certain latitudes and break out from time to time, enduring for certain unknown intervals, then disappearing to be replaced by similar phenomena." Some exceptional outbreaks, no doubt, only take place at long intervals, whilst the evidences of others remain visible for long periods.

Mr. Denning suggests that if the old drawings could be collected and suitably discussed, considerable light might be thrown on the physical changes which are ever taking place. The value of this discussion must, in a measure, depend upon the continuity of the observations, and it is suggested that, as Jupiter is now being continuously observed and delineated, there will in a few years be ample material for such a discussion.

In the meantime Mr. Denning suggests that further insight into the wonderful atmospheric phenomena of the planet might be obtained from a study of the large number of drawings made by Schwabe between 1830 and 1860, and the 300 or 400, or more, made by Schmidt between 1843 and 1880 (the *Observatory*, October, 1904).

COMPARISON OF THE INTENSITIES OF PHOTOGRAPHIC STELLAR IMAGES.—The second chapter of the "Instructions to Variable Star Observers," of which the first chapter was summarised in these columns on September 15, is published in the October number of the *Bulletin de la Société astronomique de France*. Variable star observers will find many points of interest and instruction in the present chapter, which deals with the details of obtaining suitable photographs, and afterwards comparing and reducing the plates.

OBSERVATIONS IN THE SOUTHERN HEMISPHERE.—The Lick Observatory expedition to the southern hemisphere installed its apparatus at Santiago de Chile during the southern winter of 1903, and commenced observations on September 11 (1903).

A detailed description of the instruments in use, the observations and results, is promised for a later publication, but in the meantime Prof. W. H. Wright records several important results obtained with a powerful three-prism spectroscope attached to a Cassegrainian reflector of 94 cm. aperture, in No. 2, vol. xx., of the *Astrophysical Journal*.

The stars β Doradus, w Velorum, l Carinæ, κ Pavonis, and τ Sagittarii, have been found to have variable radial velocities.

Observations of α Centauri have also been made, and indicate an average difference between the radial velocities of the two components of about 5.17 km. One probable explanation as to the cause of this difference is that it is due to the relative orbital motion of the two components, and if this is true the parallax of the system may be determined, because the visual orbit of the pair is already well known. Dr. Palmer made the computation, and obtained the following results:—

$$\pi = 0{\cdot}76''$$
$$a = 3{\cdot}46 \times 10^9 \text{ km.}$$
$$m_1 + m_2 = 1{\cdot}9.$$

a = mean distance between components in kilometres, m_1 and m_2 = the respective masses of α_1 and α_2 Centauri in terms of the sun's mass.

The relative masses of the components, as previously determined, is about 51 : 49 in favour of the brighter. The spectrum of the latter is of the solar type, whilst in that of the fainter the iron lines are more pronounced and the calcium absorption is exceedingly heavy.

THE CLASSIFICATION OF STARS ACCORDING TO THEIR TEMPERATURE AND CHEMISTRY.

I.

ALTHOUGH the observations made by Fraunhofer in 1814 first indicated that the spectra of stars were not all of the same character, it was the more systematic observations of Rutherfurd and Secchi fifty years later which revealed the fact that the different varieties of stellar spectra were, generally speaking, associated with stars of different colours. The stars with fluted spectra, for instance, were generally found to be red; those resembling the sun in having abundant metallic lines were yellowish; while those in which the chief absorption was due to hydrogen were white. Closely following these observations came Zöllner's suggestion that the spectra might indicate the relative ages of the stars, and that the yellow and red stars were older and cooler than the white ones, thus giving birth to the now generally accepted view that the different kinds of stellar spectra represent different temperature stages in the evolution of more or less similar masses of matter. More direct evidence as to temperature differences was brought forward shortly after by Ångström, who directed attention to the probability that the flutings characteristic of the red stars originated in chemical compounds, and pointed out that the occurrence of flutings in such a star as Betelgeuse might be taken as an indication that the temperature of the star was sufficiently reduced to permit the formation of chemical combinations. Subsequent researches have shown that all flutings do not proceed from compounds, but the fact remains that in laboratory experiments flutings are only produced by relatively cool vapours and gases, and their presence in the spectrum of a star may therefore be still accepted as evidence of greatly reduced temperature. The broad distinction between the spectra of cool and hot stars was thus early recognised, but it remained to establish the sequence of temperature in the stars characterised by line spectra.

It was next pointed out by Sir Norman Lockyer in 1873[1] that the spectrum of the sun was intermediate between the more complex fluted spectrum of the red stars and the simpler line spectrum of the white ones, and further that the great development of the blue end of the spectrum in the white stars, as contrasted with stars like the sun, afforded strong presumptive evidence that the white stars were the hotter. Experiments had, in fact, shown that the continuous absorption exerted by certain gases was restricted to the most refrangible part of the spectrum when the density was low, and advanced gradually into the visible spectrum as the pressure was increased. Utilising this criterion, it thus appeared that the hotter a star the simpler was its spectrum, and it was pointed out also that the metallic elements seemed to make their appearance in the order of their atomic weights. As a working hypothesis, founded primarily on results obtained in solar inquiries, it was suggested that in the atmospheres of the sun and stars various degrees of dissociation were at work, so that in some cases the atoms which compose what at terrestrial temperatures we distinguish as metals, metalloids, and compounds, were prevented from coming together. Hence "the so-called elements not present in the reversing layer of a star will be in course of formation in the coronal atmosphere, and in course of destruction as their vapour densities carry them down; and their absorptions will not only be small in consequence of the reduced pressure in that region, but what absorption there is will probably be limited wholly or in great part to the invisible violet end of the spectrum."

Secchi's classification was, of course, made quite independently of such considerations as to temperature; but being based to a great extent on the colours of the stars associated with the different spectra, the numerical sequence of his four well known types is more or less in accordance with the probable temperature gradation.

Vogel[2] was the first to propose a classification professedly depending upon the supposition that the spectrum is indicative of the phase of development which a star has reached, and making use of the condition of the blue end of the spectrum as a guide to the temperature conditions. In stars of his class i. the more refrangible portions of the spectrum are of conspicuous intensity, in class ii. the blue and violet are weaker, while in class iii., which includes Secchi's third and fourth types, this part of the spectrum is described as being strikingly feeble. This is, indeed, the principal feature which is common to the several subdivisions of each of the three classes, and, apart from such possible resemblance, it is difficult to understand, for example, how stars so widely different as Arcturus and the bright line stars of the Wolf-Rayet group could have been brought together in the same class. Thus, although the idea underlying the classification was that of decreasing temperature in passing from the first to the third class, there was no adequate attempt to define the successive positions of the various subclasses on the descending scale of temperature.

[1] *Phil. Trans.*, vol. clxiv., p. 492 (1874), and *Comptes rendus*, vol. lxxvii. p. 1357 (1873).

[2] *Ast. Nach.*, vol. lxxxiv. (1874), p. 113.

Another idea was put forward in 1887 by Sir Norman Lockyer in connection with the meteoritic hypothesis.[1] Hitherto the generally accepted view as to stellar evolution had started with the assumption that all the stars were intensely hot to begin with, and that all further development was brought about by reduction of temperature; but it was objected that all bodies in the universe cannot be finished suns in the ordinary sense, and that the old view took no account of the processes of manufacture from nebula to sun. It was then suggested that the progress of stellar development was from comparatively cool nebulæ, through uncondensed "stars" of rising temperature, to the hottest stars, with a subsequent decline, through stars like the sun, to planetary conditions. On this modified basis a new classification was proposed in which seven groups were found sufficient to include the data depending on the visual observations, which were then practically all that were available. Some such arrangement of the stars in two series is, in fact, demanded by thermodynamical principles, since a mass of gas condensing under the influence of gravitation must continue to rise in temperature so long as it remains in a condition approaching that of a perfect gas, and Prof. Darwin has shown that a condensing swarm of meteorites would behave in a similar manner.

The magnificent success which soon after attended Prof. Pickering's photographic application of Fraunhofer's method of studying stellar spectra by means of an objective prism, and the subsequent use of the same form of instrument by Sir Norman Lockyer and others, provided data for a far more searching inquiry into the processes of stellar development. Conclusions as to the relative temperatures of the stars could now be more certainly drawn from the extension of their spectra towards the ultra-violet, as shown by the photographs, and the chemical changes accompanying the variation of temperature from star to star could be much more accurately observed.

In a discussion of the photographic spectra of 171 of the brighter stars, Sir Norman Lockyer[2] again found it necessary to arrange the stars in an ascending and a descending temperature series, as was previously the case when dealing with the visual observations, and the general sequence of events demanded by the meteoritic hypothesis was therefore so far confirmed. The classification into seven groups was still retained, but various subgroups were introduced in order to include the finer shades of difference revealed by the photographs.

At this stage of the inquiry many of the stellar lines, especially in the case of the hotter stars, had not been identified with terrestrial spectra, and further progress resulted rather from laboratory than from observatory work. Sir William Ramsay's discovery of terrestrial helium permitted a complete study of the spectrum of that element, and provided a most satisfactory explanation of many of the previously unknown lines appearing in the spectra of some of the white stars, and other lines usually associated in the stars with those of helium were subsequently traced to oxygen, nitrogen, carbon, and silicium.

But there was still another great class of outstanding lines, occurring in such stars as Sirius and α Cygni, for which chemical origins could not be certainly assigned on current principles. Continuing his researches, dating from

[1] Roy. Soc. *Proc.*, vol. xliii. p. 117.

[2] *Phil. Trans.*, vol. clxxxvi. A 1893), pp. 675-726.

1879, Sir Norman Lockyer[1] made the important discovery that several of these "unknown" stellar lines were coincident with lines of iron which were enhanced in brightness in passing from the arc to the spark spectrum. What is meant precisely by "enhanced lines" may be gathered from Fig. 1, and the first idea of their relation to stellar spectra is well brought out in Fig. 2.

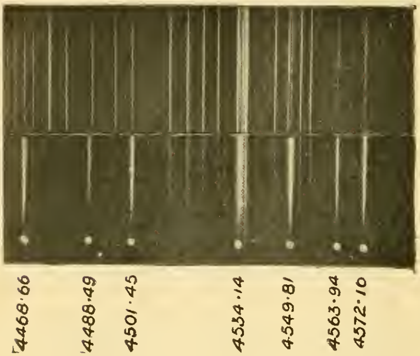


FIG. 1.—Illustrating enhanced lines of titanium; (1) arc, (2) spark.

The laboratory experiments suggested that in a space heated to the temperature of the hottest spark, and shielded from the effects of a lower temperature, the spectrum of iron would consist of these enhanced lines alone, and the outcome of the investigation was, in fact, to show that this condition is realised in the stars which are judged to be very hot by the extension of their spectra into the violet. Thus in α Orionis the continuous spectrum in the violet is feeble, and the arc lines and flutings appear without the enhanced lines; in α Cygni the violet radiation is more intense, and the enhanced lines are relatively much stronger than the arc lines; while in Rigel, with still stronger violet radiation, the enhanced lines appear in the absence of the arc lines. At a still higher stage, represented in the diagram by γ Orionis, the metallic lines have disappeared altogether, and are replaced by lines chiefly due to gases.

In a subsequent paper[2] it was shown that similar results were obtained in the case of other elements, and the presence or absence of enhanced lines, or their intensities as compared with those of the arc lines, appeared to afford a ready means of arranging stars at certain stages in order of temperature independently of a special study of the violet radiation. Adopting this mode of bringing together stars of approximately the same mean temperature, it was found, as before, that at each stage the stars were divisible into two groups, and that these groups naturally fell into two series, in each of which there was an almost unbroken sequence of changes in the line spectra. As determined in this way, stars of one series differ from those of the other at the same stage of heat:—"(1) in the greater continuous absorption in the violet or ultra-violet, (2) in the generally greater intensity and breadth of the metallic lines, (3) in the smaller thickness of the hydrogen lines, (4) in the greater thickness of the helium lines at those stages in which they are visible." The differences indicated in (2) and (3) are well illustrated by the comparison of the spectra of Sirius and α Cygni given in Fig. 3.

[1] Roy. Soc. *Proc.*, vol. lx. p. 475 (1896). [2] *Ibid*, vol. lxi., pp. 148–209 (1897).

It is to be noted that while the *relative* intensities of the arc and enhanced lines of the same metal are the same in both stars, thus indicating probable near equality of temperature, the metallic lines generally are weaker in Sirius than in α Cygni, while the lines of hydrogen behave in an exactly opposite manner.

The differences between the two series were explained by supposing, as before, that one of them comprises stars of increasing temperature and the other those which are becoming cooler. On the meteoritic hypothesis, stars of the first series would still be in the state of uncondensed swarms, and the greater thickness of effective absorbing vapours would account for the increased continuous absorption at the violet end of the spectrum, as well as for the greater thickness of the metallic lines, as compared with those stars in which a photosphere has been formed.

In 1899, in view of the fruitful results of the continued investigation of enhanced lines in relation to the stars, Sir Norman Lockyer[1] concluded that the time had arrived for a complete revision of the nomenclature of the stellar groups, and a more extensive definition of their chemical peculiarities. This new classification, in a slightly revised form, is fully stated and applied to the spectra of 470 of the brighter stars in a recent publication of the Solar Physics Committee.[2] On account of divergences of opinion among those engaged in these investigations, the same type of spectrum was referred to differently numbered groups in the various classifications which had been previously proposed, and to avoid the confusion to which this gave rise the use of numbers was entirely dispensed with. The idea underlying the new nomenclature cannot be better stated than in the words of the author, namely:—"As we know beyond all question that a series of geological strata from the most ancient to the most recent brings us in presence of different organic forms, of which the most recent are the most complex, it is natural to suppose that the many sharp changes of spectra observed in a series of stars from the highest temperature to the lowest, brings us in presence of a series of chemical forms which become more complex as the temperature is reduced. Hence we can in the stars study the actual facts relating to the workings of inorganic evolution on lines parallel to those which have already been made available in the case of organic evolution. If then we regard the typical stars as the equivalents of the typical strata, such as the Cambrian, Silurian, &c., it is convenient that the form of the words used to define them should be common to both." An adjectival form ending in *ian* was therefore suggested.

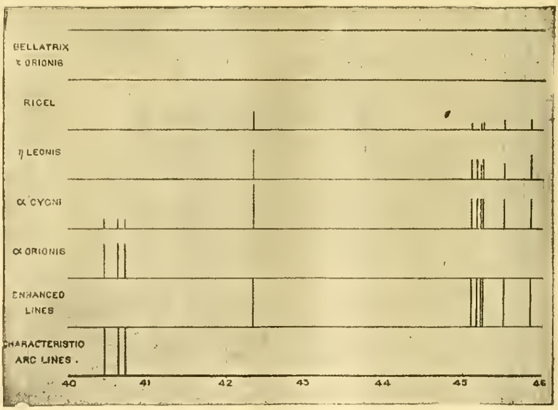


FIG. 2.—Illustrating the gradual replacement of arc lines of iron by enhanced lines in stars of increasing temperature.

[1] Roy. Soc. *Proc.*, vol. lxv. p. 186.
[2] "Catalogue of 470 of the Brighter Stars, classified according to their Chemistry." (London: H.M. Stationery Office, 1902.)

Generally, if the typical star is the brightest in the constellation to which it belongs, the Arabic name is used as a root; if the typical star be not the brightest, the name of the constellation is used in a similar manner. Thus we have *Antarian* from Antares, *Alnitamian* from Alnitam, *Taurian* from ζ Tauri, *Piscian* from 19 Piscium, and so on. In this way the names given to the various groups have very definite associations, and will doubtless be found much more convenient than the old confusing numbers and letters, even for the mere sorting of spectra into similar groups.

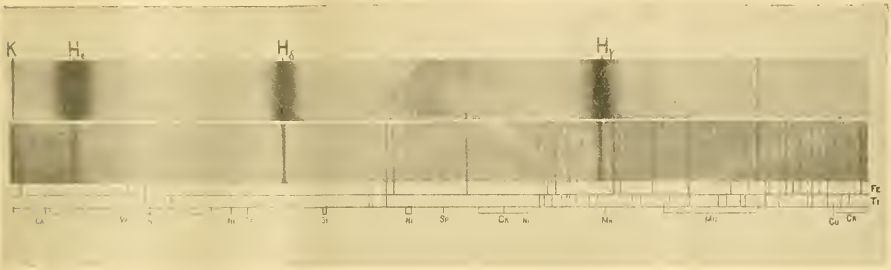


FIG. 3.—Spectra of (1) Sirius (decreasing temperature) compared with that of (2) α Cygni (increasing temperature). The chemical origins indicated are those depending upon coincidences with enhanced lines.

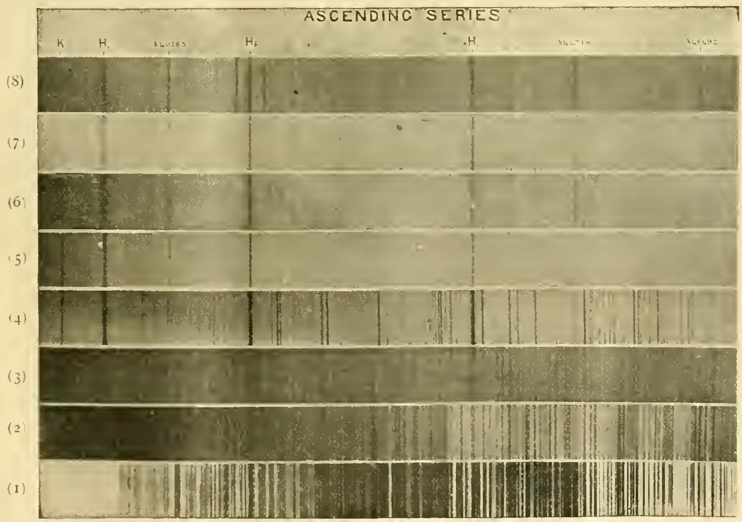


FIG. 4.—Stars of increasing temperature:—(1) α Orionis (Antarian); (2) α Tauri (Aldebarian); (3) α Persei (Polarian); (4) α Cygni (Cygnian); (5) β Orionis (Rigelian); (6) ζ Tauri (Taurian); (7) γ Orionis (Crucian); (8) ε Orionis (Alnitamian).

Bearing in mind the important distinction to be drawn between enhanced lines and the ordinary arc lines of a metal, a new term was found necessary for the proper chemical definition of several of the groups. When a substance is represented by lines which have their greatest development in the arc spectrum its ordinary name suffices; but when its presence is manifested by enhanced lines the prefix "*proto*" is added, the idea being that a substance reduced to the state in which it gives such lines is subjected to some sort of molecular simplification resulting from the dissociating effects of increased temperature. In the case of hydrogen, the proto-lines have not yet been even partially produced in laboratory experiments, but that they are really due to hydrogen is sufficiently demonstrated by the "series" connection of their wave-lengths with the wave-lengths of the more familiar lines of that element. Silicium exhibits four distinct line spectra under different conditions, and it has been found convenient to refer to these in numbered groups. It would be out of place here to reproduce all the minute details of the new classification, but referring only to the most characteristic lines of the various stellar groups, the classification may be shortly stated as follows, the prefix "p" signifying "proto":—

Argonian (γ Argûs).—H, p H.

Alnitamian (ε Orionis).—H, He, λ4649, Si IV.

Proto-metallic lines relatively thick, hydrogen relatively thin.	Proto-metallic lines relatively thin, hydrogen relatively thick.
Crucian (α Crucis).—H, He, Ast, O, N, C.	*Achernian* (α Eridani).—Same as Crucian.
Taurian (ζ Tauri).—H, He, p Mg, Ast.	*Algolian* (β Persei).—H, p Mg, p Ca, He, Si II.
Rigelian (β Orionis).—H, p Ca, p Mg, He, Si II.	*Markabian* (α Pegasi).—H, p Ca, p Mg, Si II.
Cygnian (α Cygni).—H, p Ca, p Mg, p Fe, Si II., p Ti, p Cr.	*Sirian* (α Canis Maj.).—H, p Ca, p Mg, p Fe, Si II.
Polarian (α Urs. Min.).—p Ca, p Ti, H, p Mg, p Fe, Ca, Fe, Mn, Si I.	*Procyonian* (α Canis Min.).—Same as Polarian.
Aldebarian (α Tauri).—p Ca, Fe, Ca, Mn, p Sr, H, Si I.	*Arcturian* (α Boötis).—Same as Aldebarian (includes the Sun).
Antarian (α Scorpionis).—Flutings of manganese,[1] and many metallic lines.	*Piscian* (19 Piscium).—Flutings of carbon and many metallic lines.
[Nebulæ.]	[Dark Stars.]

[1] Many of the flutings have since been shown to be due to titanium [Fowler, Roy. Soc. *Proc.*, vol. lxxiii. p. 219 (1904)]. The flutings are most strongly developed in the less refrangible parts of the spectrum, and are not seen in the spectrum of Betelgeuse reproduced in Fig. 4.

Examples illustrating most of the groups are given in Figs. 4 and 5, from negatives taken by Sir Norman Lockyer and his assistants at the Solar Physics Observatory. These bring out very clearly the gradual simplification of the spectrum in the first series as the temperature rises, and the increasing complexity in the second series as the temperature falls. On the dissociation hypothesis, we have first to deal chiefly with relatively cool metallic vapours, which, as the temperature rises, are brought by *dissociation* to the proto-metallic stage, and finally to the gaseous condition represented by hydrogen and helium; then, through subsequent cooling, *association* begins and produces somewhat similar changes in inverse order.

A. FOWLER.

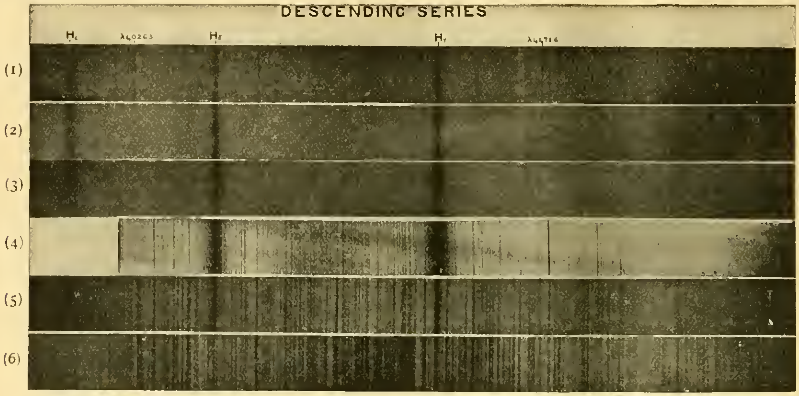


FIG 5.—Stars of decreasing temperature:—(1) γ Orionis (Crucian); (2) β Persei (Algolian); (3) α Pegasi (Markabian); (4) α Canis Majoris (Sirian); (5) α Canis Minoris (Procyonian); (6) α Boötis (Arcturian).

RECENT IMPROVEMENTS IN THE DIFFRACTION PROCESS OF COLOUR-PHOTOGRAPHY.[1]

THE fundamental principles of the diffraction process of colour-photography will be found in my earlier papers on the subject.[2] In brief, the method consists in preparing by photographic means a picture in which the areas which are to appear coloured are represented by diffraction gratings of various spacings. A grating ruled on glass, when combined with a convex lens and directed towards a lamp flame or other source of light, forms diffraction spectra in the focal plane of the lens. If the pupil of the eye is brought into the red portion of one of these spectra, we perceive the entire surface of the grating illuminated in red light, since every portion sends red light, and red light only, into the eye. If a second grating with closer ruling is substituted for the first, the eye remaining fixed in position, the spectra will occupy different positions, and if the pupil of the eye occupies, say, the green region of one of them, this grating will appear green. If the two gratings are placed side by side, and overlapping one another, the one will appear red, the other green, while the overlapping region, since it sends both red and green light to the eye, appears yellow (secondary yellow). If a third grating of still finer spacing is now placed before the lens, partly overlapping the other two, it will appear illuminated in blue-violet light, and the overlapping portions will be coloured purple, white, and bluish-green.

We may in this way obtain a large variety of colour with only three rulings, and since the intensity of the light depends on the distinctness with which the lines are ruled or photographed, light and shadow can be obtained solely by the presence of the diffracting lines. The portions of the plate on which they are absent send no light to the eye, and appear black.

A full description of the method by which photographs showing the colours of the original object were prepared will be found in the papers above referred to.

The earlier experiments were made with very imperfect gratings, the periodic errors of which caused the pictures to show vertical bands of colour. During the past winter I have ruled gratings of various description on one of the Rowland engines, and continued the experiments of five years ago.

This machine was designed to rule 14,438 lines to the inch, but by employing larger cams, which cause the pawl to skip a specified number of teeth, it may be made to rule at the rate of 7219, 4812, 3609, and so on. Calculations showed that gratings ruled on this machine with cams which advanced the toothed rim of the large wheel five, six, and seven teeth respectively would be suitable, that is, would have the relative spacings necessary to produce white when they were superposed.

To illustrate the principle of the colour synthesis, a glass plate was ruled with the three spacings, the ruled squares overlapping as shown in Fig. 1*a*. The areas appeared coloured as indicated when the plate was placed in front

[1] Paper read before Section A of the British Association at the Cambridge meeting by Prof. R. W. Wood.

[2] Wood, "Application of the Diffraction Grating to Colour-photography" (*Phil. Mag.*, April, 1899); "Diffraction Process of Colour-photography," (NATURE, vol. lx. p. 199, 1899).

of the viewing lens. The white area in the centre was of good quality, though not quite so bright as in the photographic gratings, for the reason that the three sets of rulings were rather more than the glass surface would take without breaking down between the lines. Photographic copies of this multiple ruling have been made, and will probably prove useful in demonstrating colour synthesis.

The appearance of two overlapping rulings under the microscope is shown in Fig. 1*b*.

It would appear at first sight as if a ruling of this description would be incapable of giving distinct spectra, and we should certainly not expect it to give merely the superposed spectra of the two gratings.

As a matter of fact, secondary spectra are produced, though they are usually so faint that they give no trouble. In some cases, however, owing to some peculiarity of the form of the groove, the photographic copies when superposed do not give the expected colour. For example, in one exceptionally pronounced case, the superposition of the red and violet gratings gave, instead of purple, a brilliant yellow-green.

The origin of the secondary spectra can be seen in the following way. If the red and violet gratings are superposed with the lines mutually perpendicular, and a lamp is viewed through the combination, the spectra appear as in

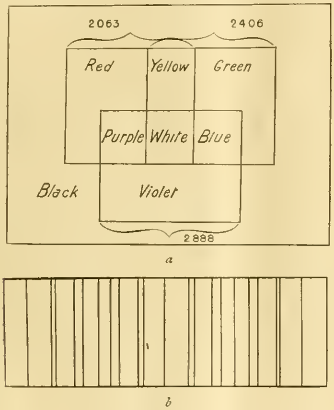


FIG. 1.

Fig. 2, the secondary spectra being usually much fainter than the principal ones. If, now, one of the gratings is slowly rotated through a right angle, the spectra will gradually wheel around into a straight line, and the secondary spectra will be found to fall *between* the principal spectra. In the particular case alluded to above, the secondary spectra for some reason or other were brighter than the principal, and it was found that the yellow-green of one of them fell at the point where the red and violet of two of the principal spectra coincided. This accounted for the abnormal colour which appeared in this case. It is very seldom, however, that these abnormal colours appear in the pictures.

A set of gratings for the production of colour photographs was ruled on this machine, and results far superior to any that had ever been obtained before were immediately secured. A few of the pictures were of such excellence as to compare favourably with the results obtained in the Kromshop. The method of preparing the pictures was essentially as I have described in previous papers.

The diffraction process has also been successfully combined with the Joly process. To accomplish this it was necessary to rule the three sets of lines in bands corresponding to the width of the red, green, and blue lines of the Joly screen. Calculation showed that if 12 lines were ruled with the 5-tooth cam, 10 with the 6-tooth, and 9 with the 5-tooth, the spaces would be about right.

Various schemes for making a ruling of this description were considered, but no satisfactory automatic device appeared to be possible, since the period of the bands on the Joly screen could not be exactly duplicated by any combination of cams.

The following simple device was finally hit upon. The engine was equipped with the 7-tooth cam, and a small stepped piece of brass mounted under the lever which operated the pawl, which, by preventing the complete descent of the lever, caused an advance of only 6 teeth or 5 teeth according to its position. The Joly screen was mounted on the table of the engine under a microscope, and the transit of the coloured lines across the × hair in the eye-piece observed, the rate of the ruling being changed at the proper moment by sliding the stepped piece of brass into the proper position, which was done by means of a short brass rod. The ruling of the grating occupied twelve hours, during which time I was obliged to sit with my eye constantly at the microscope, for the change of rate occurred about every half minute. Two very satisfactory gratings were prepared in this way, one corresponding to the Joly screen and the other to one of the screens ruled on the machine of the McDonough Co., of Chicago.

These gratings when placed in the viewing apparatus appeared white and very brilliant, and were easily duplicated by photography.

They were used in the following way:—

A positive on glass, made from a Joly negative, was flowed with a thin solution of gelatin sensitised with

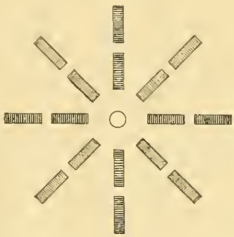


FIG. 2.

bichromate of potash, and allowed to dry. The triple ruled grating was then placed with its ruled surface in contact with the sensitive film, and held before the lens of the viewing apparatus. The appearance of the picture was now precisely similar to the appearance when a Joly colour screen was used, and the lines could be brought into register at once, when the picture appeared in its natural colours. A ten-second exposure to the light of the arc recorded the grating lines on the film, and the plate was then dipped into warm water and dried. The colours of the picture prepared in this way were fully equal, if not superior, to those obtained with the Joly viewing screen. There is the added advantage that the colour lines and picture lines are on one and the same film, consequently there is no liability of the lines to get out of register. Moreover, the picture can be duplicated by contact printing on glass sensitised with chrom-gelatin. These prints are, of course, quite transparent until they are placed in the viewing apparatus, when the coloured picture at once appears.

By this means the trichromatic screen, which in the Joly process must be mounted with every picture, is done away with, and a picture obtained which can be easily duplicated. To offset the advantages gained we have, however, the disadvantage that the pictures require the viewing apparatus, and show the same obtrusive lines as the original Joly pictures. The triple diffraction screen could easily be ruled with its colour elements much closer together, but we should gain nothing in this way until some method of taking a negative with narrower colour elements is devised.

The pictures made by the old method with three separate

gratings can, I believe, be very much improved, as soon as some better method of printing gratings is devised. I have worked exclusively with chrom-gelatin, and it is by no means easy to get a film of such uniform thickness that the print made on it appears uniformly illuminated.

During the past summer I made some experiments with Prof. Lippmann, of Paris, on copying gratings by means of the plates which he uses in his process of colour-photography. These plates are much more sensitive than chrom-gelatin plates, are orthochromatic, and yield gratings of great brilliancy and uniformity. Whether they are capable of receiving two or more impressions remains to be seen. If they are it will probably be possible to form a diffraction colour-photograph directly in the camera, in the manner suggested in one of my earlier papers.

Moreover, if the triple ruling can be transferred in any way to the Joly taking screen, it is obvious that the *negative* taken by means of it in the camera will, when placed in the viewing apparatus, appear as a positive in natural colours; we can thus obtain our coloured positive at once in the camera, and make as many duplicates from it as we please by contact printing.

THE AGRICULTURAL EDUCATION CONFERENCE AT GLOUCESTER.

UNDER the auspices of the Gloucestershire County Council, a conference on agricultural education was held at the Shire Hall, Gloucester, on October 15. There was a large attendance not only of those locally interested in either education or agriculture, but also of delegates from many of the other counties. After a few preliminary remarks from the chairman, Sir John Dorington, Lord Onslow opened the proceedings, and explained the work his department was charged with in regard to education. He justified the retention of that work by the Board of Agriculture instead of allowing it to be merged in the general educational system administered by the Board of Education, on the plea that agriculture in England was so far from being the leading industry that the specialised education it required would get scant attention were there not his own department peculiarly interested in fostering it. He claimed that the constant and sympathetic communication between the two departments secured more favourable results than could be acquired under the Board of Education exclusively. The work of the Board of Agriculture was confined to assisting the collegiate centres under which the greater part of the country was now grouped; there was, however, a large blank on the educational map, for the whole of the west country, including Gloucestershire itself, had no centre of university rank from which agricultural instruction emanated. He trusted that the present conference would pave the way towards remedying the need he had indicated.

Sir William Hart-Dyke, to whom the first paper, on higher agricultural education, had been entrusted, was unable to be present; his paper, of which an abstract was read, warned the meeting of the difficulty that now confronted all counties in the matter of higher education because of the great draft on their funds for the future training of elementary schoolmasters.

A paper by Prof. Middleton, of Cambridge University, next dealt with the proper function of experimental plots in local agricultural education; Prof. Percival, of Reading, who followed, dealt with the ideal course of instruction in an agricultural college. The current courses, he maintained, were far too scientific; chemistry, botany and kindred sciences should be reduced to a minimum in favour of work on the farm, a thoroughly popular programme which appealed to the "practical men" in the room.

Lord Monteagle then opened the second part of the proceedings, on the education of the small farmer, with an account of the way the Irish Board of Agriculture had gone to work.

In Ireland the central authority administered the larger part of the funds, contributing five-ninths of the cost of any work, and securing four-ninths from the local authority; thus the organisation proceeded more evenly over the whole country than in England, where the initiative rests with the local authority. Next, they had proceeded in Ireland on the principle of establishing no institution until they had created a demand for it by means of pioneer lecturing and demonstrations. Lastly, in Ireland they believed that the industrial organisation of the farmers must go hand in hand with their education.

Prof. Wallace, of Edinburgh, who followed, dwelt on the necessity of beginning an agricultural training at an early age, so far as practical work on the farm went, leaving the true technical instruction to come when the lad had matured. Mr. Frederick Verney also dwelt on the harm that was being done to country children by keeping them at unsuitable school subjects until they had lost all taste for farming pursuits; the present system of elementary education contributed both to the depopulation of the country and the overcrowding of the towns.

Mr. H. Hobhouse, M.P., spoke on the value of attaching agricultural sides to the ordinary country grammar schools; the training would not be technical, but scientific with an agricultural bias.

After lunch Mr. Morant expressed his pleasure at the opportunity the conference afforded him of learning the feelings of the great agricultural community towards the educational system of the country. He assured the meeting that the Board of Education was wholly anxious to assist, provided the men who represented agriculture on such occasions would make their views precise, and, instead of grumbling at large, would indicate exactly what worked harshly or harmfully in the present arrangements controlled by the Board of Education.

A paper by Sir C. Dyke Acland was then read in his absence; it dealt with the education of the labourer, and was, like so many that followed, a plea for more intelligent teaching in our elementary schools, and for a more flexible system which would partially liberate boys at an earlier age for light work on the farm. Mr. G. Lambert, M.P., and Mr. Martin F. Sutton emphasised this point of view, and, like Mr. Acland, they agreed that in the main rural labour difficulties had been caused by keeping the rate of wages too low, with consequent loss of efficiency.

The last section of the conference, on the education of the teacher and expert, was opened by Mr. A. D. Hall, who pleaded for a more rigorous training which should include some experience in farming for the teacher of agriculture, and some work at research for the man who dealt with agricultural science. Canon Steward, principal of the Salisbury Training College, discussed more generally the education of the elementary schoolmaster and mistress in country districts, and finally, Mr. R. P. Ward gave an account of the way the teachers were being trained in Cheshire.

In the discussion which followed most of the speakers urged the substitution of winter schools or of evening continuation schools for the compulsory attendance of country boys at school up to the age of fourteen; for farming purposes a boy ought to begin light work on the farm at the age of twelve at latest, though his education should go on much later than it does now.

The conference was noteworthy not only for the quality of the papers read, but for the advance they showed in the direction of organisation on those submitted to previous conferences. It was made clear that there are several different classes to be provided for; the large farmer's son or future land agent wants a different equipment from that of the small holder; the farmer himself must be reached by an entirely different method; the labourer, again, has to be treated separately. At Gloucester the various speakers defined clearly their aim and their method; in former gatherings of the same nature the speakers seemed to consider there was only one kind of worker engaged in agriculture.

THE SPREAD OF PLAGUE.[1]

IN accordance with our views on the origin of epidemics it is necessary to believe that the plague which appeared in Bombay in the autumn of 1896 was derived from some previously infected locality. Two such localities have been

[1] Substance of a paper read before the Section of Physiology at the Cambridge meeting of the British Association on August 19 by Dr. E. H. Hankin.

suggested. The most obvious suggestion is to the effect that it was derived from Hong Kong, which town had been the seat of a serious epidemic in 1894, and which in 1896 remained still infected. An alternative suggestion was put forward in the report of the German Plague Commission to the effect that it was derived from Garhwal. The suggestion was to some extent substantiated by the fact mentioned in the report in question that two thousand fakirs from Garhwal had arrived in Bombay on their way to a pilgrimage at Nassik shortly before the appearance of the disease. Plague is endemic in Garhwal (a district in the Himalaya Mountains), and this locality is therefore a possible source of infection. By conversation with a fakir who had attended the Nassik festival, Mr. Hankin learnt that the Garhwal fakirs only visit western India on occasions when the Nassik festival is being held. This festival is held regularly at twelve-yearly intervals.

It occurred to Mr. Hankin that if Garhwal was the source of the Bombay plague, by means of fakirs, it might also be the source of previous epidemics of plague in western India. On counting backwards from 1896 by twelve-yearly intervals, one arrives at 1836, the date of the Pali plague, and at 1812, the date of the Gujerat plague. That is to say, of the eight occasions on which these fakirs visited western India during the nineteenth century, on no less than three an outbreak of plague appeared. This fact may be regarded as strongly substantiating the suggestion of the German Plague Commission as to the origin of the Bombay outbreak. Further, it is stated by Forbes that the Pali plague originated in a village a few miles distant from the town of Pali shortly after the arrival of some wandering fakirs, and that it was preceded by a mortality among the rats. It was pointed out that these three plagues of western India had certain characters in common in which they differed from the majority of plagues in other parts of the world. First, they were characterised by their greater intensity and persistence; secondly, during the greater part of their course, at all events, they showed more virulence in villages than in towns; thirdly, they spread over the affected country, like a wave, from village to village, and showed but little tendency to travel along trade routes; fourthly, in each of the outbreaks the pneumonic form of the disease was frequently observed. The fact that these outbreaks resembled each other, and differed in general from outbreaks elsewhere, in the above characters, accords with the idea that they have a common origin. One apparent exception, however, which is of great importance must be described. This is the black death. So far as evidence goes, this outbreak was distinguished by each of the characters that have been ascribed to Indian plagues. In order, therefore, to be able to hold that Indian plague is of Garhwal origin, it is necessary to show that the black death may possibly have been derived from the same source.

The black death is known to have been imported into Europe from the town of Caffa, in the Crimea, where the Tartar army had been besieging some Italian merchants. According to an Arab historian, Aboel Mahasin, the plague was brought to the Tartar army from Tartary, where it was present in the year 1346, if not earlier. At that period, trade in horses and merchandise existed between India and Tartary. It is therefore necessary to investigate whether a Nassik festival occurred shortly before that time, and whether it was accompanied by an outbreak of pestilence. At first sight a study of Indian history appeared to negative the suggestion. It is stated, however, in Elphinstone's "History of India" that a rebellion broke out in Ma'bar in 1341, and that the army sent to suppress it was destroyed by plague. It appeared desirable to investigate this statement in detail. Counting back by twelve-yearly intervals, we arrive at 1344 as the year of a Nassik festival. In view of the great antiquity of Indian religious festivals, we are safe in assuming that in that year a number of fakirs emerged from Garhwal on their way to the sacred shrine. Ma'bar is situated on the Coromandel coast, on the Madras side of India, and one would expect that the army of the Emperor of Delhi would not march anywhere near to Nassik. But a contemporary history dealing with the conquest of Ma'bar, some thirty-five years previously, describes minutely the route then followed by the army. It appears to have lain through, or near, Nassik, and that the soldiers must have marched along the same route as the fakirs for all the first part of their journey. It is further recorded that when the army was destroyed by pestilence the Emperor himself was attacked, and that when suffering from the disease he halted at Deogiri, a town close to Nassik. It appears from a contemporary history that the army originally sent in 1341 was insufficient for its purpose, that the Emperor returned for reinforcements at a time when a famine was raging in Delhi, and that it was these reinforcements that were destroyed by the pestilence. The date of the famine is given as 1344. This is also given as the date at which the campaign terminated, and at which the rebels recovered their independence. Thus we have evidence that a plague broke out near Nassik in the year 1344, at a time when Garhwal fakirs were present, and it is obvious that this plague may have been carried to Tartary in time to have been the precursor of the black death, which is first known to have been present there in the year 1346. Other suggestions as to the origin of the black death, as, for instance, that it came from China, or from the supposed endemic area in Mesopotamia, or from the then existing endemic area of the Levant, if not contradicted by known facts, are at least unsupported by any positive evidence.

Prof. G. S. Woodhead asked whether it was known to what the pneumonic form of plague was due. Was it due to extra virulence or to the climatic conditions?

Sir Edward Candy asked if the outbreaks of plague in 1812 and 1836 spread and continued in the same manner as that of 1896, which re-appeared for some time after with every return of cold weather. It was noteworthy that the plague of 1896 took hold of the country up to the Punjaub, but missed out Calcutta and Madras.

In the course of his reply, Mr. Hankin pointed out that it was a remarkable fact that the pneumonic form of the disease showed but little tendency to spread as such by direct infection from person to person. Mr. Hankin had found that the plague virus lost its virulence by passages through rats. It was possible that it would also lose its virulence by passages through human beings, and that the true nidus of the disease in which it could retain or regain its virulence was to be found in some other living organism, as, for example, some species of flea. With regard to the important point raised by Sir Edward Candy as to the spread of plague, Mr. Hankin stated that it was a necessary corollary of his theory that the present outbreak of plague in India had not established itself in any other part of the world. It was probable that plague was carried from Hong Kong to Noumea, to Australia, to Madagascar, thence to South Africa, Oporto, and other localities. The present pandemic of plague was essentially a disease of sea-ports, in the first instance, and then of towns. It but rarely established itself in villages, and then always rapidly died out. In this and in other characters it showed itself distinctly different from the Indian form of the disease.

INVESTIGATIONS ON THE NUTRITION OF MAN.[1]

PROF. W. O. ATWATER, Middletown, Connecticut, chief of nutrition investigators of the United States Department of Agriculture, gave an account of the inquiry regarding the food and nutrition of man which is carried out in the United States by authority of Congress. The work is done by cooperation between the Department of Agriculture and a large number of universities, experiment stations, and other organisations from Maine to California. The headquarters is at Wesleyan University, Middletown, Connecticut, where the speaker, who is in charge of the work, is situated. The Federal Government devotes 20,000 dollars (4000*l.*) a year to the enterprise. This is used mainly as aid to research, and is supplemented by grants of money and other aid from State Governments and other sources. The inquiry has three aspects, one very practical, another more purely scientific, and a third educational.

On the practical side studies are made of the composition, the digestibility, and the nutritive values of food materials

[1] Abstract of an address before the Sections of Physiology and Economics at the Cambridge meeting of the British Association on August 23.

commonly used in the United States. This is done by chemical analyses and by actual experiments with men. Investigations are also made of the kinds, amounts, and costs of the food consumed by people of different classes and occupations in different parts of the country. The results throw valuable light upon the physiological, hygienic, and economic phases of the subject. At the same time experiments are made on various collateral topics, and thus information of the greatest usefulness is being acquired.

The more abstract scientific researches have to do with the transformations of matter and energy in the body, and consequently with the fundamental laws of nutrition. The experiments are made with men by use of the respiration calorimeter, an apparatus which serves to measure the changes which take place in the body with different diets and under different conditions, as, for instance, with physical or mental work or of rest. One very interesting result is the demonstration that the law of the conservation of energy obtains in the living body. Such purely scientific research is difficult and costly, but the speaker insisted earnestly upon its fundamental importance. These experiments show very clearly how the demands of the body for energy, for warmth, and work decide the needs for food. Taken in connection with the practical inquiries, they reveal much that was previously unknown regarding the uses of food and the adaptation of diet to health, purse, and welfare.

Numerous illustrations were given of the results of these inquiries. The average man on average diet digests and utilises about 96 per cent. of the material and 91 per cent. of the energy of his food, the rest being rejected in the excretory products; but the proportions thus utilised vary with the person, and still more with the food. The investigations bring out these differences in much detail.

The question of the nutritive values of bread made from ordinary white flour as compared with the whole wheat meal or brown flour, such as is used to make "brown bread," was considered. Chemical analysis shows that the bran which is removed in making the white flour contains considerable quantities of nitrogenous materials, and also of mineral matters, such as phosphates. A natural inference is that when the miller removes the bran he takes out the most valuable part of the flour. But the analysis in the chemical laboratory is not the same as that in the human body. The digestive apparatus of man has not the power to utilise the bran, consequently, when we eat the meal from the whole wheat we digest the part which makes the white flour and reject most of the ingredients of the bran. Cattle and sheep can digest the bran; the miller is therefore right in selling the bran for fodder for stock, and the white flour bread for man. This last statement perhaps requires a slight qualification. A large number of experiments with healthy men show that the nitrogenous ingredients of the bran escape digestion when made into bread, so that 1 lb. of white flour furnishes more digestible material than 1 lb. of the whole wheat meal; but it may be that the body obtains more phosphates from the whole wheat. This last question is still under investigation. The present probability, however, is that the chief value of the bran is as a stimulant to digestion in some cases where peristaltic action or the secretion of digestive juices is enfeebled.

While Prof. Atwater could hardly adopt the vegetarian theory of diet, he believed that the idea of the needs of large amounts of meat is often greatly exaggerated.

The investigations emphasise the great importance of a liberal diet for people engaged in muscular labour. They make it clear that in many cases the food of the poor is inadequate for normal nourishment, and must remain so until they have larger incomes or cheaper food.

The investigations also bring out clearly the reasons why people with sedentary occupations need less food than those with more physical exercise. Mental labour differs from muscular labour in requiring much less material and energy for its support. In general, people with sedentary occupations have the larger, and those whose labour is manual the smaller, incomes. Thus it comes about that the well-to-do are apt to be over-fed and the poor under-fed.

The application of these principles to some of the economic questions of the day was emphasised. High value was placed upon the inquiries of Mr. Rowntree regarding the conditions of living of the labouring classes in York. Other investigations in England and Scotland were referred to, and the statements of Mr. Charles Booth, in his monumental work on "Life and Labour in London," regarding the need of such an inquiry in Great Britain were quoted with approval.

"Half the struggle of life is a struggle for food"; half the wages of the bread-winner are spent on the food for himself and his family. Little regard is paid to the relation between the real nutritive value of food and its cost. The poor man's money is worst spent in the market, the poor man's food is worst cooked and served at home; here it is emphatically true that "To him that hath, shall be given, and from him that hath not, shall be taken away even that which he hath."

The importance of proper diet as an aid to temperance reform was emphasised. In countless cases in the United States, and he presumed the same was true in England, the home diet of the labouring classes is not what it should be, and the cooking and the serving of the food are the opposite of attractive. It is not strange that the people take to drink. One place to work against the evil of alcohol is at the table.

The educational aspect of the subject was also dwelt upon. The Federal and State Governments which support these inquiries, and the institutions and individuals who carry them on, lay great stress upon the distribution of the results among the people at large. Not only are the details printed in scientific memoirs, but the practical outcome is condensed in pamphlets and leaflets which the Government prints literally by the million, and distributes gratuitously. Copies of these publications were shown. Schools, from the lower grades to the universities, are introducing the subject into their curricula, and leading educators are coming to recognise that when such themes are treated in the true scientific spirit as revelations of natural law, and their significance and their connection with life and thought are explained, they are valuable both for mental discipline and for daily use. It is not a lowering, but a broadening, of the ideal of education which thus makes these subjects in the best sense humanistic.

In closing, Prof. Atwater urged the importance of such inquiries. He showed how they were already being actively pursued in the different countries of the world, in Europe, in Japan, and in the United States, and suggested that the time had come for the development of the science of the comparative nutrition of mankind.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following appointments are announced: Prof. Marshall Ward, F.R.S., to be a member of the general board of studies; Dr. W. E. Dixon to be assistant to the Downing professor of medicine; Mr. P. V. Bevan to be demonstrator, and Mr. C. Chittock to be assistant demonstrator, of experimental physics; Mr. J. J. Lister, F.R.S., to occupy the university table at the Plymouth Marine Biological Laboratory; Mr. J. W. Clark to be an additional manager of the Balfour Fund.

MR. H. M. MACDONALD, F.R.S., has been appointed professor of mathematics in the University of Aberdeen.

THE death is announced of Mr. Alonzo B. Cornell, who was the founder of Cornell University, and gave special attention to the development of teaching of scientific subjects at the university.

A COURSE of ten lectures on "The Chemistry of Proteids," by Dr. S. B. Schryver, was commenced on Wednesday, October 19, in the physiological theatre, University College, London, and will be continued on following Wednesdays at 5 p.m. The lectures are open to all internal students of the university, and also to medical men on presentation of their cards.

IT is reported, says *Science*, that about 60,000*l*. is left to public institutions by Mrs. Elizabeth Green Kelly, including 20,000*l*. to the University of Chicago. We learn from the same source that the will of Mrs. Sarah B. Potter, of Boston, contains public bequests aggregating more than

200,000*l*., including 30,000*l*. to the Boston Medical Library and 10,000*l*. to Harvard University. It is also announced that the increased appropriations for Miami University by the Legislature of the State of Ohio at its last session have rendered it possible to enlarge the science hall, given by Senator Brice, to about three times its present capacity. The new Brice Hall will be occupied by the departments of chemistry, physics, and biology of the Liberal Arts College, and by the natural history department of the State Normal School. The University of Southern California, at Los Angeles, is also to be extended by a new building to cost 20,000*l*. It will be devoted to the science departments.

AN attempt is being made to establish an association of teachers of science, art, and technology who are engaged in teaching at London institutions. It is hoped that the new association may become ultimately a national body. It has been agreed at meetings already held that the principal aims and objects of the association should be the general advancement of technical education; the interchange of ideas regarding methods of teaching technical subjects; the promotion and safeguarding of the professional interests of the members of the association in such matters as tenure, pensions, and registration; to lay the views of the association before educational authorities and before the public; and to enable the members to cooperate as a body with other scientific and educational associations. Arrangements have been made for a general meeting to be held on October 22 at the Birkbeck College, Chancery Lane, at 3.30. All London teachers of science, art, and technology, other than those employed in secondary schools, are invited to be present. Fuller particulars may be obtained from Mr. J. Wilson, head of the chemical department, Battersea Polytechnic, who is acting as temporary honorary secretary.

THE annual report of the Glasgow and West of Scotland Technical College, recently adopted by the governors of the institution, shows that the first section of the new buildings has proceeded satisfactorily. The main structure is nearly completed, and the internal equipment is advanced sufficiently to permit of the occupation of a few rooms during the present session. It does not seem possible to proceed immediately with the erection of the second section. The subscriptions to the building fund amount to 186,525*l*.; the cost of the first section will be 140,000*l*., and to this must be added 44,654*l*., the cost of the site. The second section will cost at least 60,000*l*., and the governors appeal for further contributions to enable them to erect the whole of the buildings. It is estimated that the equipment of the first section will mean an expenditure of 40,000*l*. Conditional upon a new fund of this amount being raised for the purpose, the Carnegie University Trust promised a grant of 5000*l*. A second grant of 5000*l*. from the Education Department and other subscriptions have been placed to the credit of the fund, which now stands at 18,135*l*. The governors hope that they will soon be placed in a position to claim the grant conditionally promised by the trust. It is worthy of note that the total number of individual students reaches 5333, of whom 489 are adult day students, 4212 evening students, and 632 pupils of Allan Glen's School.

AN article on the selection of Rhodes scholars in connection with the Rhodes Scholarship Bequest was contributed to the *Times* of October 13 by Dr. G. R. Parkin. It appears that during the present month about seventy-five men, the first large group of scholars selected, enter on residence at Oxford University. Canada, Australia, South Africa, New Zealand, Newfoundland, Bermuda, and Jamaica, within the Empire, and, outside the Empire, Germany and the United States, with the exception of a few States where no suitable candidate was found, will have their representatives. In 1905 a larger number will probably be selected; in 1906 scholars will be chosen only from colonies of the Empire and from Germany, to which annual scholarships are assigned, whereas each of the United States has only two scholarships in three years. Thus in 1906 the full number—about 190 in all—provided for under the bequest will be in residence. It is interesting to note that the men sent as scholars are selected, where practicable, from colleges or universities rather than from secondary schools. It has been decided that throughout the United States generally only those candidates shall be eligible who have done at least two years' work at a recognised degree-granting university or college. In cases where the committee of any State expressly asks leave to appoint from secondary schools this leave is granted. The limits of eligible age were placed between nineteen and twenty-five. The public interest taken in the organisation of the scheme of award has been most striking. It will probably take some time to complete a system of selection which is beyond criticism, but a fair beginning seems to have been made in giving practical effect to the conception of the testator.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 5.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. G. H. **Verrall** exhibited specimens of (*a*) *Callicera yerburyi*, Verr., a Syrphid new to science, taken this year in Scotland by Colonel J. W. Yerbury, and (*b*) *C. aenea*, F., the other British species of the genus, together with three European species of Callicera, *C. macquatii*, *C. spinolae*, and *C. porrii*.—Mr. H. St. J. **Donisthorpe** exhibited *Tetropium fuscum*, L. (♂ and ♀), and *Abdera 4-fasciata*, Curt., taken by him at Market Bosworth, Leicestershire.—The Rev. F. D. **Morice** exhibited cells constructed by two wasps, *Polistes gallicus* and *Eumenes coarctatus*, found by him in the Balearic Islands.—Mr. A. J. **Chitty** exhibited specimens of the earwig *Apterygida media* (*albipennis*), found originally by Westwood, and hitherto recorded only from Norfolk. He had taken the species at Huntingfield and Charing, Kent, this year.—Mr. W. J. **Lucas** exhibited a living specimen of *Labidura riparia*, ♂, from the shore near Christchurch, Hants, kept alive for more than a month, and fed upon fruit, meat, &c.—Prof. Hudson **Beare** exhibited on behalf of Mr. C. J. C. Poole specimens of *Aulonium sulcatum*, Oliv., a beetle new to the British fauna.—Mr. W. **Dannatt** exhibited a specimen of *Papilio homerus* from the Blue Mountains, Jamaica, and three new butterflies, *Chloríppe godmani*, from Venezuela, *Delias hempeli*, from Gilolo, and *Monethe johnstoni*, from British Guiana.—Dr. T. A. **Chapman** exhibited for Mr. Hugh Main a teratological specimen of *Arctia caja*, bred this year. Immediately below the costa the left hind wing divided into three layers, each of which was apparently a normal wing so far as form, colour, and markings went, but which, when the insect was alive, were so closely applied to each other as to look like one normal wing, until they were separated.—Mr. F. **Merrifield** exhibited pod-like galls found on a terebinthine shrub in the limestone region of Auvergne, apparently those of *Pemphigus cornicularius*.—Mr. Norman **Joy** exhibited the black variety of *Bledius taurus*, Germ., taken at Wells, Norfolk, August, 1904; *Bledius femoralis*, Gyll, from Wokingham, Berks, a species that has not been taken in the British Isles for more than fifty years; *Polydrucsus sericens*, from Hampshire; *Neuraphes carinatus*, Mul., from Bradfield, near Reading; a small form of *Dyschirius politus*, Dej., taken at Bridlington and at Wokingham; and a Rhizotrogus (? species), taken in some numbers near Streatley, Berks.—Dr. F. A. **Dixey** exhibited some preparations of the scent of male Pierine butterflies, and read a note descriptive of the same.—Mr. H. J. **Turner** exhibited living examples of the larva of *Phorodesma smaragdaria* from the Essex marshes. He also contributed notes on the life-histories, and living larvæ and cases, of several Coleophorids, among them *C. vibicella*, a species which, although generally distributed on the Continent, has only been recorded from a few English localities.—Mr. G. J. **Arrow** read a paper on sound production in the lamellicorn beetles.—Prof. C. **Aurivillius** communicated a paper on new species of African Striphnapterygidæ, Notdontidæ, and Chrysapalonidæ in the British Museum.—Mr. A. H. **Swinton** communicated a paper on the droughts and weather, and insect increase and migration.—Mr. E. Ernest **Green** communicated a paper on some new mosquitoes from Ceylon, by Frederick V. Theobald.

MANCHESTER.

Literary and Philosophical Society, October 4.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—Mr. Charles **Bailey** exhibited some specimens of *Sisymbrium strictissimum*, L., which had been sent him by Mr. James E. McDonald, of Stockport, as occurring at Heaton Mersey, where it had been established for the last fifteen years. He remarked that this genus, apart from the aboriginal species, was already represented in Lancashire and Cheshire by two aliens, *S. polyceratium* at Birkenhead, and *S. pannonicum* at St. Anne's-on-the-Sea and elsewhere. *S. strictissimum* is, therefore, a third colonist of this genus which has obtained a permanent footing in our flora.—Prof. W. Boyd **Dawkins,** F.R.S., directed attention to a new cause of folding of the rock other than that which has been long recognised by geologists as ultimately due to the folding of the outer layers of the earth as they follow the contracting nucleus. The deep cuts made through valleys to make watertight barriers in the construction of reservoirs revealed the fact that the bottom of the valleys, wherever it was formed of shales and thin sandstones, was more or less folded and contorted. These folds and contortions caused the shales to let the water through with more or less freedom, and he had been called in repeatedly to advise as to how far it was necessary to carry the puddle trenches down below the valley bottom. He found, as a matter of experience, that these folds were superficial, and if the sinking were made to a sufficient depth below the bottom of the valley they disappeared altogether. It was therefore obvious that they were not due to deep-seated movements of compression resulting from the contraction of the earth. They are due to the relaxation of pressure caused by the removal of the rock by denudation from the area of the valley, and are analogous in every particular to "the creep" in coal workings, caused by the excavation of coal, by which the surrounding strata crush down into the area of relaxed pressure and ultimately fill it up. This may be studied in any coal pit where there is a superincumbent pressure, say, of more than 1000 feet. The two following illustrations of folding and faulting by relaxation of pressure are presented by the puddle trench of the Langsett reservoir belonging to the Sheffield Corporation, and by the two reservoirs now under construction on the head waters of the Derwent by the Derwent Water Board. In the first of these the foldings in question at the bottom of the valley in the shale under the first grit are strongly marked at the surface. These folds gradually disappear, and are based upon a hard black unmoved shale offering a good foundation about 60 feet below the bottom of the valley. This is in the valley of the little Don. The thickness of rock removed from the bottom of the valley amounted to no less than something like 8000 feet of Coal-measures and Millstone Grit. In the case of the Derwent, in which the folding is much more marked and is accompanied by faulting, the thickness of rock removed amounted to at least 9700 feet (7200 feet of Coal-measures, 2000 feet of Millstone Grit, and at least 500 feet of Yoredale). In this the movement had not extended beyond a depth of 90 feet. In the case of the Derwent reservoir lower down the river there are two systems of folding and faulting which do not penetrate beyond 60 feet from the surface. At that point a good foundation is found for the puddle trench of the embankment.

PARIS.

Academy of Sciences, October 10.—M. Mascart in the chair.—The discontinuity of the external work of muscles compared with the discontinuity of their internal work from the point of view of the energy expenditure of the contraction: A. **Chauveau.** The results of two sets of experiments are given graphically.—On Perrot's experiment: Louis **Maillard.** A preliminary account of some qualitative results is given. In the first set of experiments twelve succeeded out of twenty-one. In a second set, in which greater precautions were taken to ensure the stability of the receiver, and to avoid currents of air and temperature changes, thirty-one out of thirty-three experiments were successful.—Colour photographs obtained by the interference method without using the mercury mirror: E. **Rothé.** A careful examination of some photographs taken by Lippmann's method led to the conclusion that it ought to be possible, by prolonged exposure, to obtain photographs in colour by the reflection of light on the air-gelatine surface only, and this has been proved experimentally. The method presents the advantages of being applicable in any apparatus without the use of special material.—On the temperatures of transformation of steels: Georges **Charpy** and Louis **Grenet.** Three methods were applied to each sample, making use of the electrical resistance, the expansion, and the thermoelectric power. It was found that the thermoelectric and dilatometric methods show no well marked correlation except for the softer steels. On the other hand, the results furnished by the electrical resistance and dilatometric methods agree closely qualitatively and even quantitatively within the limits of experimental error.—Substituted derivatives of phenyldiazoaminobenzene: Léo **Vignon** and M. **Simonet.** The preparation and properties of several substitution derivatives of phenyldiazoaminobenzene are described. These substances are easily prepared by the interaction of the substituted diazoanilines with diphenylamine, and possess the general properties of the diazoamines, being usually unstable.—The influence of castration on the physique: Eugène **Pittard.**—Culture of a trypanosome of the frog: A. **Billet.**—On some Hæmoflagellæ of marine Teleostea: C. **Lebailly.**—New geological observations on underground sheets of water in the Brenner district: Pierre **Termier.**

CONTENTS.

THURSDAY, OCTOBER 27, 1904.

HALLER'S COMPARATIVE ANATOMY.

Lehrbuch der vergleichenden Anatomie. By B. Haller. Pp. viii+914. Erste Lief., pp. vi+424, price 8 marks; Zweite Lief., pp. viii+425 to 914, price 12 marks; illustrated. (Jena: Gustav Fischer, 1904.)

IN his preface the author explains that his aim in writing this book was to produce a modern work on the lines of the second or last edition of Gegenbaur's "Grundriss der vergleichenden Anatomie," which was published twenty-four years ago. The book deals in a concise manner with the structure of all animals from the Protozoa to the highest Vertebrata. The character and mode of treatment of the subject will be sufficiently described by the statement that the author closely follows in Gegenbaur's footsteps. For his material he has drawn very largely from Gegenbaur's recent "Vergleichende Anatomie der Wirbelthiere" (1898 and 1901); but as he devotes much more space almost half the book—to the Invertebrata than is given to this branch of the subject in the latter work, he has freely used the facts and illustrations found in the great treatises of A. Lang and Korschelt and Heider in compiling the first part.

The whole book, with the exception of the part dealing with the structure of the brain of vertebrates, concerning which the author has published some original memoirs ("Morphologisches Jahrbuch," 1898 and 1900), is obviously a compilation, and not from the original writings, but from such books (themselves of necessity largely compilations) as have already been mentioned. The result is what one would naturally expect. The book reproduces many of the mistakes of the works from which it is derived, and adds not a few misinterpretations which do not occur in these; the information is not up to date. The author is, for example, unaware of J. P. Hill's discovery of a placenta in the Marsupialia, and is apparently ignorant of Willey's work on Balanoglossus; the descriptions are disjointed and difficult to understand, such as would be written by one who has no adequate practical acquaintance with the facts, or has not digested the mass of pabulum with which he is dealing. Anyone who has had occasion to make use of the last edition of Gegenbaur's "Vergleichende Anatomie" knows to how great a degree this work fails to reach the high level of the first edition, which was written when the author was in his prime. In the last edition Gegenbaur relied in too many cases upon the immature work of young contributors to the "Morphologisches Jahrbuch" in preference to more trustworthy researches published elsewhere. All such faults are reproduced in Haller's book.

The attempt to cover so vast a field as the entire animal kingdom is such a colossal undertaking in the present state of knowledge that one hesitates before hastily passing judgment on the work as a whole. In such circumstances the reviewer naturally turns for an estimate to those parts of the book in which the author might claim to write as an expert. The portion dealing with the brain of the Vertebrata is almost entirely original.

The difficulty of understanding the author's meaning which characterises the greater part of the book is greatly increased in the case of the nervous system by his frequent abuse of terms and the needless invention of new names for structures which already have designations familiar to all anatomists. But, in addition, his account of the brain is so studded with inaccuracies that the mere enumeration of them would fill the whole space devoted to this review. It is sufficient to quote only a few from among many others equally astounding. While he correctly locates the caudal limit of the forebrain on the dorsal side at the posterior commissure, he places it on the ventral side at the junction between the mid- and hind-brain, which he calls "sulcus interencephalicus" (p. 623 and elsewhere). In reptiles, birds, and mammals he calls the paraterminal body (which in mammals becomes converted into the septum lucidum and the precommissural area) by the name "gyrus fornicatus"—a term which is employed by all other anatomists to designate a strip of neopallium above the corpus callosum (pp. 633 and 638 *inter alia*). To add to the confusion, he labels the fascia dentata in a marsupial brain "gyrus fornicatus" (p. 640). In figures of the brains of reptiles, birds, and a mammal (rabbit), he labels as "sulcus coronarius" furrows which are certainly not homologous the one with the other; and even in the mammal it is not the "coronary" but the "lateral" sulcus on which he has placed the label. On p. 638 he refers to the hippocampus as "part of the occipital lobe," and on the preceding page he states that the occipital lobe is separated from the frontal lobe in Echidna by the Sylvian fissure; by the latter term he refers to a furrow (*p*, Fig. 629), which resembles the Sylvian fissure neither in form nor in position. But the most erroneous and hopelessly muddled parts of his account of the brain are his numerous references to the cerebral commissures. He seems to imagine that the "fimbria" and "fornix" (names applied by anatomists to different parts of the *same* series of hippocampal fibres) are independent structures, and he refers to the fornix-commissure by the term "fimbria-commissure," and applies the former term in one place to a part of the anterior commissure, which has no connection whatever with the fornix, and in another place to the corpus callosum! To this amazing confusion he adds the further error of attributing to Phascolomys a corpus callosum like that of Erinaceus, and representing an utterly different state of affairs in Didelphys, whereas all marsupials lack a true corpus callosum.

His spelling of many terms is somewhat peculiar. As examples I might quote "thalam*o*cephalon" (p. 636), "rhin*o*cephalon" (p. 638), "t*h*ela" (p. 637), and "corpus callos*i*" (in several places).

If we judge the whole work by the part to which the author has devoted his chief attention no condemnation of it can be considered too harsh. It is confused, inaccurate, and difficult to understand.

The book has one great redeeming feature in its numerous illustrations. They are, on the whole, well

chosen, clearly and yet artistically drawn, and excellently reproduced. The sources from which they were derived are indicated in some cases only, although a number of the unacknowledged figures will be familiar to the readers of zoological literature.

There is an unduly large number of misprints in the book, especially in the lettering and the inscriptions of the various figures. There is no bibliography.

G. E. S.

LIQUID CRYSTALS.

Flüssige Kristalle: sowie Plastizität von Kristallen im Allgemeinen, Molekulare Umlagerungen und Aggregatzustandänderungen. By Dr. O. Lehmann. Pp. vi+264; atlas of 39 photographic plates. (Leipzig: W. Engelmann, 1904.) Price *1l.* net.

WHATEVER may be the ultimate conclusion of physicists concerning the explanation of the interesting phenomena described by the author of this volume under the term "liquid crystals," and however diverse may be the views entertained as to their bearing on current molecular theories, there can be no difference of opinion as to the value of the work before us, in which the description of these phenomena is so clearly set forth and so fully illustrated.

It was in 1889 that Dr. Otto Lehmann, the professor of physics in the Technical High School of Karlsruhe, and the author of many memoirs dealing with the application of microscopical methods to physical research, first suggested the use of this term "liquid crystals." The acceptance of the term by physicists and crystallographers has not been by any means universal or unqualified, and in certain quarters it has been received with something like ridicule. The general attitude which, with our present knowledge of the subject, it may be wise to preserve was well expressed by Prof. Miers in an article upon the subject which he contributed to *Science Progress* of January, 1897:—

"It will be wise to retain the names crystal and crystalline in their old significations, rather than to extend them so as to include the birefringent liquids whose existence has been established by Lehmann. It may be that these remarkable drops are examples of liquid matter in which particles while free to move are compelled to preserve the same orientation, and differ in this respect from ordinary liquids. But whether this peculiarity of structure, whatever may be its nature, is really analogous to that of solid crystals is a question in which it will be better not to commit ourselves to an answer by applying the same name to both until more is known about the structure both of liquids and solids."

It is not probable that the present volume will materially affect the cautious verdict pronounced by Prof. Miers, seven years ago, on behalf of crystallographers and physicists, for although many new and interesting observations are added to those announced in Prof. O. Lehmann's earlier memoirs, there is nothing in the work before us which can be regarded as supplying absolutely conclusive or crucial evidence on the subject.

In his original memoir Dr. O. Lehmann was able to confirm the observations of Reinitzer and of Gattermann that certain organic compounds possess two melting points, and he showed that, at temperatures between these two melting points, the substances, though possessing the freedom of motion of liquids, affect polarised light like crystals, and, like crystals, exhibit the phenomenon of dichroism.

In the treatise under review the list of organic compounds exhibiting these remarkable properties is considerably augmented, though all the newly described substances are closely allied in their chemical nature to those previously known. Dr. O. Lehmann proposes to divide them into two classes—"Fliessende Krystalle," in which between the two melting points the crystal retains something of its original form, modified by the rounding of the edges and angles, though two of them brought into contact have sufficient mobility to enable them to unite; and true "Flüssige Krystalle," in which, although the original crystal form is wholly lost and the substance forms rounded and very mobile drops, the double refracting and other optical properties of the crystal are nevertheless retained. It is, however, admitted by Lehmann that the distinction between these two classes of substances is neither very definite nor of fundamental character.

It is impossible in the space at our command, even if such a course were desirable, to enter upon the discussion of the physical relations of solids and liquids which the author bases on his observations. On many points he arrives at conclusions in marked opposition to those maintained by Butschli, Nernst, Ostwald, and other physicists.

By the aid of the beautiful photographs, so admirably reproduced in the plates, and the numerous diagrammatic figures in the text, the reader will find it possible to follow and understand the very interesting observations of the author. The value of the photographs would certainly have been increased if, in every case, the degree of magnification had been indicated; and a detailed description of the plates with a good index would have added to the value of this very important treatise.

THE TESTING OF STEELS.

Relations between the Effects of Stresses Slowly Applied and of Stresses Suddenly Applied in the Case of Iron and Steel. Comparative Tests with Notched and Plain Bars. By Pierre Breuil. Pp. vii+152+23 plates. *Jour.* Iron and Steel Inst. Supplement, vol. lxv. (London: Iron and Steel Institute, 1904.)

CONSIDERATION of the subject of tests and testing should be approached with a very open mind, not only because it is the common meeting ground of the engineer and the metallurgist, but because it is a difficult subject of compromise, where the selected method is practically never ideal. Steel is necessarily as often submitted to tests which it is hoped will give a measure of its qualities as to those stresses to which it will be exposed in practice. The latter is the practical ideal test short of behaviour in actual use, which is seldom feasible, as often the finish of the test would require to be left to another generation. Thus the real purpose of tyres or rails is to wear well without breaking; nevertheless, they are often tested

to destruction by a falling weight, and the material invariably so in tension.

Again, some members of a girder are in tension, others in compression, while practically all are passed on the measure of their qualities given by the tensile test. For a certain elastic limit and maximum stress the highest elongation and reduction in area are assumed to indicate the toughest steel. For materials where great toughness is of paramount importance, the tensile, cold bending, and even quenched bending are typical tests, and on the whole they have served well; but in perhaps one case out of many thousands mild steel snaps in use without elongation after satisfying all ordinary tests for ductility. Cases such as these, which, though rare, may entail great loss of life or, as in the case of certain parts of vessels of war, might mean disaster to a whole crew, have probably been the exciting cause which has set men on the search for some means of detecting these rare cases where the risk would justify the extra expense.

It is evident that this case of one in thousands cannot be touched by experiments on (to quote the author) "no less than five tons of various kinds of specially manufactured metal," for that particular one must be found by the real test of failure in ordinary use and experiments made on it. The author's unconditional advocacy of the plain tensile and bending tests, and scornful reference to the others, indicates either that he is happy in a paradise which need not be specified or that many eminent practical and scientific engineers and metallurgists are at the present day unnecessarily anxious. No one would advocate the abolition of the tensile tests, as they are required for the engineer's calculations, and are generally a sufficient guarantee of trustworthiness. The sole contention is that in certain special cases something more is necessary.

The reviewer has been engaged during the last two years with Prof. Arnold on this very matter, subjecting steels known to have failed in use to Arnold's alternating stress and other tests with a view to find a practical system which will eliminate those possessing this curious brittleness. Two steels, one the best modern make of boiler plate, the other a steel which gave passable tensile tests and bent close double without a sign of distress, yet broke during the official hydraulic tests, gave very different results under the special alternating stress test. These statements having reference to facts, no study of comparative tests on specially manufactured steels can strike at the root of the matter. Although to certain mechanical testers and men of figures the variations in some of the results from the newer methods may look somewhat formidable when presented as percentages, the fact remains that these tests have picked out dangerous steels which had satisfactorily passed tensile and bending tests. Therefore some such new system of testing claims the special attention of the designer of high-speed and other work where large issues, and possibly loss of life, would be involved by the failure of a member.

This volume is the Carnegie gold medal thesis for the year, and deals with experiments on tensile tests, on plain and on notched bars, slowly applied. Many figures are given on the effect of size and form of notch. Plain and nicked bends slowly applied and as impact tests are also considered, but excuse is made that the subject is so large that it could not be adequately dealt with. The present writer is firmly convinced that it would count more for real solid progress if the Carnegie scholars were encouraged to take a smaller field and explore it more thoroughly, for to a steel metallurgist a brief paper embodying definite and concrete results is far more valuable than a voluminous and indefinite thesis. It is worthy of note that the 0·7 per cent. and 0·4 per cent. carbon steels contained 0·34 per cent. and 0·22 per cent. silicon respectively, amounts that would debar their acceptance under British specifications, not on account of the tensile tests, but because of their suspected greater liability to break under vibration.

A. McW.

CHEMISTRY OF THE PROTEIDS.

Chemie der Eiweisskörper. By Dr. Otto Cohnheim. Zweite Auflage. Pp. xii + 313. (Brunswick: Vieweg und Sohn, 1904.) Price 8.50 marks.

ALTHOUGH only four years have elapsed since the first edition of this work appeared, the great advances made in our knowledge of the chemistry of the proteids have necessitated a considerable revision of the book. The author, however, has found it possible to avoid any enlargement of the work by altering the order of subjects treated, and by stating the facts more concisely than in the previous edition. Some of the alterations in arrangement appear somewhat difficult to justify. Thus, for example, in the earlier edition the physical characters were dealt with prior to the consideration of the more purely chemical properties of the proteids, while in this edition the order is reversed. As the first edition has been already reviewed in Nature, only a brief account of the chief additions to the second will be necessary.

Perhaps the most important recent additions to our knowledge have consisted in the more complete separation and identification of the products of the hydrolytic decomposition of the proteids. Dr. Cohnheim gives an excellent account of the results obtained in this field by E. Fischer and his pupils by means of the method of fractional distillation under reduced pressure of the ethyl esters of the amino-acids. This method has secured a much more complete separation of the amino-acids than any methods previously employed, although the results obtained are still far from quantitative. By its use E. Fischer has been able to prove that certain amino-acids, namely, α-amino-valerianic and α-amino-β-oxypropionic acids, are much more widely distributed products of proteid hydrolysis than has been hitherto supposed. Fischer has also succeeded in separating two acids, namely, α-pyrrolidincarboxylic and oxy-α-pyrrolidincarboxylic acids, which were hitherto unknown as products of the decompositions of proteids. The latter acid was isolated from the residue remaining after distilling off the esters of the amino-acids. A full account is also given of recent work on the more complete chemical characterisation of the amino-acids, including the separation of several into optically active isomers.

The isolation and determination of the probable constitution of tryptophane by Hopkins and Cole, and that of oxyphenylæthylamine by Langstein and Emerson, may also be mentioned as some of the most important additions to our knowledge of the products of the hydrolysis of the proteids by the action of trypsin. Dr. Cohnheim appears to have omitted to mention the discovery of the latter substance.

Our knowledge of the chemistry of the diamino-acids and other basic products of hydrolysis has not been so markedly increased. The constitution of histidin has not yet been determined, although the evidence so far obtained points to it being a pyrimidine derivative. The discovery by Herzog that it gives the biuret reaction is of much importance in view of the fact that this test has been used to distinguish between the more complex products of proteolysis which still retain proteid characters and the simpler chemical bodies resulting from more complete decomposition.

The tables compiled by Dr. Cohnheim which give the nature and quantity of the products of hydrolysis of various proteids and albuminoids form a very useful addition to the book.

The third chapter of the general part of the work gives an interesting account of the chief views held with regard to the constitution of the proteids. The most interesting advance in this field is due to E. Fischer, who has shown that the amino-acids possess in a marked degree the power of reacting with one another to form more complex bodies. The prototype of these substances—glycylglycin—results from the union of two molecules of glycin with the elimination of the elements of water, the amine group of the one molecule reacting with the carboxylic group of the other to form an amide. By extending this synthesis Fischer has succeeded in preparing compounds of three or more molecules of various amino-acids to form compounds which he terms polypeptides. Some of the more complex polypeptides resemble peptones in many of their chemical properties.

In the special part of the work the section on the proteids of plants has been much extended. The section on nucleoproteids gives a good account of recent work elucidating the constitution of the pyrimidine derivatives, uracil, thymin, and cytosin. Considerable additions, embodying the work of Nencki and Zaleski, and of Küster on the decomposition of hæmatin, have also been made to the chapter on the blood pigments.

The second edition of the work well maintains the high standard for completeness and accuracy secured by the first one.

OUR BOOK SHELF.

Elements of General Radio-Therapy for Practitioners. By Dr. Leopold Freund, Vienna. Translated by Dr. G. H. Lancashire. Pp. xix+538; illustrated. (New York and London: Rebman, Ltd., 1904.) Price 21*s*. net.

Dr. Freund is so well known to English workers in electrotherapeutics that any work written by him will be welcome. To his earliest writings the profession is largely indebted for the first experimental work in radio-therapy, and the results were sufficient to indicate the possibilities of X-rays in therapeutic work as well as in diagnosis. The work before us shows that Dr. Freund has based his experimental research upon a thoroughly scientific knowledge of what has been done by others as well as by himself, and consequently all workers with X-rays will feel indebted to him for his book and gratefully acknowledge this.

In his preface Dr. Freund states that he has attempted to bring the essential features of a recent form of treatment before the notice of a larger circle of medical men, that he has tried in a comprehensive way to explain the technique, the indications for treatment and the results to be expected, while at the same time tabulating and arranging the fundamental physical laws so as to explain the physiological effects. That he has succeeded no one will doubt who reads the work, and that the views of others have not been forgotten is made evident by the fact that he quotes more than eight hundred writers upon the subject. The author admits that this branch of science can hardly be said to be more than in its infancy, that there are gaps in our knowledge to be filled in and errors to be corrected; but notwithstanding the doubt expressed in some quarters we have already achieved brilliant theoretical and practical results which lead him to hope that radio-therapy will obtain an acknowledged place among our methods of treatment. In support of this view he says one need only refer to the undeniable and astonishing results already achieved in skin disease.

After a short but expressive introduction referring to the physical aspect of the question, Dr. Freund divides the work into five sections. The first deals with the elements of electricity, and this section should be useful to medical practitioners who are desirous of obtaining the acquaintance with physics necessary to understand this special branch of surgery. The second part treats fully of high-frequency currents, the third section is devoted to X-rays, the fourth to Becquerel rays, and the fifth to treatment with heat and light rays.

A careful perusal of the different chapters will convince anyone that Dr. Freund has fully succeeded in his aims; and that the text-book under notice will become a popular one is certain. That it will be regarded as one of the standard works on the subject no one can doubt.

English workers are largely indebted to Dr. Lancashire for his excellent translation of the work, and to Mr. Clarence A. Wright for his notes on instrumentation published in connection with the English edition, which are introduced at the end of the book.

The whole is clearly and scientifically written. There are one hundred and seven illustrations taken from the original text, and the author, translator, and publisher are to be congratulated upon the success of their efforts.

Physiography. An Introduction to the Study of Nature. By T. H. Huxley. Revised and partly re-written by Prof. R. A. Gregory. Pp. xi+423; with 301 illustrations. (London: Macmillan and Co., Ltd., 1904.) Price 4*s*. 6*d*.

The task of revising and bringing up to date Huxley's inspiring text-book of physiography was one not to be lightly undertaken, but it could not well have been placed in better hands than those of Prof. Gregory. In spite of the many fine qualities of the original volume, and of the author's belief that its methods could be adapted with little difficulty to any locality by an intelligent teacher, it can scarcely be questioned that the usefulness of the book was somewhat restricted by its special reference to the Thames and its basin.

In its new form, however, the book no longer specially appeals to those who dwell in this neighbourhood, but is equally applicable to any river basin.

While the value of the book is undoubtedly much enhanced by the judicious additions which have been made to the text, the most notable feature of the new edition is the abundance of excellent illustrations. The majority of these are from actual photographs, and depict a great variety of natural objects and phenomena, among which are clouds, glaciers, volcanoes, earthquakes, and geological structures. This unique collection of photographs, each of which is of real value, makes the book of quite exceptional interest, and it is pleasant to learn that many of the pictures have been generously contributed out of regard for the memory of Huxley. The scope of the subject, as here set forth, is such as to make it the natural complement of the "nature-study" which refers chiefly to the various forms of life. That is to say, it is regarded entirely as an introductory subject, dealing with inanimate nature; and it may be remarked that it does not unduly encroach on the domains of physics, chemistry, or astronomy. We are glad to note that instructions for practical work, which is obviously essential to make the study of the greatest educational value, are in course of preparation. Meanwhile, the present book will be heartily welcomed as a clear, attractive, and trustworthy introduction to the study of science. A. F.

Die Theorie der Direkten Anpassung und ihre Bedeutung für das Anpassungs- und Deszendenzproblem. Versuch einer methodologischen Kritik des Erklärungsprinzipes und der botanischen Tatsachen des Lamarckismus. By Dr. Carl Detto. Pp. 214; mit 17 Abbildungen im Text. (Jena: Gustav Fischer, 1904). Price 4 marks.

Of two well-known tenets of Lamarckism, the inheritance of acquired characters, and the power of "direct adaptation" on the part of the individual organism, the consideration of the former is relegated to a few pages at the end of the present work, which is mainly concerned in combating the latter. This pro-Darwinian book is, in fact, occupied in an endeavour to prove that individual organisms possess no mysterious and inexplicable power of adjusting themselves to their surroundings, and that from this point of view the theoretical basis of Lamarckism is unsatisfactory. The first two chapters largely deal with psychological considerations, terminology, and definitions. The third chapter quotes and considers the views of Lamarck, H. Spencer, Eimer, Warming, von Wettstein, and others, so far as they relate to "direct adaptation." The fourth chapter (pp. 81–188) is devoted to the discussion of the facts and phenomena that are usually cited as demonstrating the power of direct adaptability on the part of individual organisms, and to alternative explanations of these. It is this chapter that will appeal most to the busy botanist, who, after ascertaining the meaning of the two new terms "œcologism" and "œcogenesis," may find it advisable to commence the book at this point. The following selected headings suffice to illustrate the kind of subjects dealt with:—methods of interpretation of the facts of "direct adaptation"; direct adaptation in bacteria, fungi (including a discussion of a biological species of Uredineæ), and Euglena; physiological adaptation among highly organised plants (races produced by nutrition, climatic adaptation in respect to duration); structural adaptations among highly organised plants (œcological convergence of types; parallel variation in xerophytes, hydrophytes, halophytes; shade-leaves).

The Photographic Reference Book. Edited by J. McIntosh. Second edition. Pp. 344. (London: Iliffe and Sons, Ltd., 1904.) Price 1s. 6d. net.

The first edition of this book was chiefly compiled by using the columns devoted to answers to correspondents of *Photography* as a basis, the work being undertaken by Messrs. W. A. Watts and Henry Sturmey. In the present issue the material has been largely rewritten and much new matter added, so that the book may be considered as practically a new one. The editor has, however, confined himself to the original object for which the book was written, namely, a worker's handbook, and as such the reader will find that the present volume is a handy and useful *vade mecum*. The great point about a work of this character, if it is to be useful, is the facility with which any information that is desired can be found and correctly given. Both these desiderata are here, for a capital index supplies the former and the paragraphs under the different headings complete the latter. Many subjects were chosen at random, and in each case the facts required were easily found and fully given. As a book of reference this issue should be the companion of many photographers.

Transactions of the South African Philosophical Society. Vol. xiii. Part i. Pp. 1–293; plates 1–4 (43–46 of the whole series). Descriptive Catalogue of the Coleoptera of South Africa (Lucanidæ and Scarabæidæ). By L. Péringuey. (Cape Town, 1904.)

An exceedingly valuable synopsis of South African Coleoptera, chiefly by Mr. Péringuey, the worthy successor of Mr. Trimen in the South African Museum, is at present being published in the above named *Transactions*. Vol. xii. was devoted to the descriptive catalogue of Lucanidæ and Scarabæidæ, and vol. xiii., a goodly instalment of which now lies before us, continues the subject. It includes the subfamilies Sericinæ (tribes Sericini and Ablaberini) and Melolonthinæ (tribes Pachypodini, Sparrmannini, and the first four groups of the Melolonthini). Many of the species figured are very handsome, resembling in miniature the magnificent Goliath beetles of the west coast of Africa. The work is too highly technical for detailed notice here, but the excellent tables and descriptions of genera and species will render it very useful to students of South African Coleoptera. We hope in time to possess equally elaborate works on the insects of all the British colonies. W. F. K.

Toning Bromides and Lantern Slides. By C. Winthrope Somerville, F.R.P.S. Pp. 72. (London: Dawbarn and Ward, Ltd., 1904.) Price 1s. net.

This is a collection of formulæ for many methods, practically, perhaps, all the methods in use, for toning "bromide" prints. Lantern slides do not appear to be mentioned in the text, and it can hardly be supposed that all the processes given are available for them, as, for example, the "hypo and alum, or 'boiling' process." Perhaps in future editions this part of the subject will receive more attention. The author is enthusiastically in favour of the choice of bromide printing rather than the other methods of photographic printing available. To him it is "the ideal of the present day." He actually compares it with platinum and carbon printing to the disadvantage of these for fineness of result, and claims for it an equal permanency. Of course many will not agree with the author in this, but it is an advantage to have the formulæ preferred by one who thoroughly believes that the process treated of is altogether the best, and to have the results of his experience.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Further Discovery of Dodos' Bones.

SINCE the astonishing discovery, in 1865, of innumerable bones of the dodo in the peat of the Mare aux Songes by Mr. George Clark, of Mahébourg, in Mauritius (*Ibis*, 1866, pp. 141–146), whereby Prof. Owen was enabled to describe the greater part of the skeleton of that remarkable bird (*Trans.* Zool. Soc., vi. pp. 49–80), and the subsequent researches at the same place of Mr. Sauzier in 1889, the results of which, when worked out by Sir Edward Newton and Dr. Gadow (*Trans.* Zool. Soc., xiii. pp. 281–302), almost wholly completed our knowledge of its osteology—besides affording evidence of the former existence of other contemporary species now extinct—nothing more has been recorded on the subject.[1] It was therefore with great interest that, just five years ago, October, 1899, I received a letter from M. E. Thirioux informing me of his having found, in the preceding month of August, some remains of at least two dodos in a small, partly collapsed cave, about 800 feet above the sea, and about two miles and a half from Port Louis. Encouraged by this success M. Thirioux continued his operations, a matter of some difficulty, not to say danger, from time to time, and was good enough to keep me acquainted with many of the results, sending me photographs of the bones which he was fortunate in disinterring from the soil. They were not all dodos' bones, but some belonged to other extirpated forms of birds—as the brevipennate parrot (Lophopsittacus), the "Poule Rouge" (Aphanapteryx), and the coot—and reptiles—as Didosaurus and one or more of the land tortoises—all of which are very imperfectly known, while some of the small dodo bones are of great rarity, and at least one of them (the pygostyle) had not been seen before. From that time until very recently M. Thirioux has been continuing his researches, and has consequently formed a very considerable collection, which he now writes to me he has disposed of to the Museum of Mauritius, and I can but express the fervent hope that some competent person may be found to work it out and publish a memoir on it which will be a worthy successor to those that I have already mentioned. ALFRED NEWTON.

Cambridge, October 20.

The Forest-pig of Central Africa.

THERE are two good mounted specimens of the forest-pig in the Museum of the Congo Free State at Tervueren, near Brussels, where I had the pleasure of examining them in July last. M. A. Dubois, conservator of the Royal Museum of Natural History at Brussels, told me that he intended to describe the animal in conjunction with Dr. Matschie, of Berlin, but I am not aware that their description has yet been published, so that I hope the forest-pig may remain known by the excellent name Hylochœrus, proposed for it by Mr. Thomas.

As regards the "third mysterious animal" of the Congo Forest alluded to by Sir Harry Johnston in his letter on this subject (NATURE, p. 601), I have little doubt that it was the fine antelope of the genus Tragelaphus, lately described by Mr. Thomas as *Boocephalus euryceros isaacsoni* (*Ann. Nat. Hist.* (7), v. p. 310, and *Proc.* Zool. Soc., 1902, ii. p. 319). The first pair of horns of this species was obtained by Mr. F. J. Jackson in 1897 (see *Proc.* Zool. Soc., 1897, p. 455), but it is only recently that the perfect specimen which now adorns the mammal gallery of the British Museum was procured.

The "abnormally developed horns of the cow eland" referred to by Sir Harry Johnston have nothing to do with this antelope. They will be found fully described and figured in the "Book of Antelopes" (vol. iv. p. 209).

P. L. SCLATER.

[1] Some reputed dodos' bones, said to have been found in a cavern (*Proc.* Zool. Soc., 1885, p. 719), turned out to be turkeys' (*op. cit.*, 1890, p. 402).

Average Number of Kinsfolk in each Degree.

THE letter you forward to me from Prof. G. H. Bryan gives an opportunity of discussing the question somewhat more thoroughly than space allowed in my brief memoir of September 29.

The writer says:—"Is Dr. Galton's deduction of $d-\frac{1}{2}$ correct? I should have thought that if a parent had d male and d female children, each female child would have $d-1$ sisters and d brothers."

The objection holds good only on the erroneous supposition that each and every family of $2d$ children consists of d boys and d girls; it does not hold good on my supposition that each such family contains *on the average* d boys and d girls. The inclusion of the omitted word introduces a new set of considerations. They depend on the variety of the possible forms of combination of boys and girls in $2d$ children, which are $2d+1$ in number, and on the frequency of each of these forms, which is given by the $d+1$ terms of the binomial expansion of $(1+1)^{2d}$. The exact character of the process concerned is clearly appreciated by thoroughly working out some particular case, say that of $d=2\frac{1}{2}$, where the number of children, $2d$, in each family will be 5. There are then 6 possible combinations of boys and girls, forming 6 different classes, shown in the first three lines of the table.

(1)	Classes	I.	II.	III.	IV.	V.	VI.	
(2)	Boys in each family	5	4	3	2	1	0	
(3)	Girls in each family	0	1	2	3	4	5	
(4)	Sisters in each family ...	—	—	2	6	12	20	Totals
(5)	No. of families in each class	1	5	10	10	5	1	32
(6)	Girls in all the families ..	—	5	20	30	20	5	80
(7)	Sisters in all the families...	—	—	20	60	60	20	160

In line (4) is shown the number of sisters in any *one* family of each of these classes ($n.(n-1)$ sisters to n girls). Thus in each family in class vi. there are 5 girls, consequently $5\times4=20$ sisters, in class v. there are 4 girls, and $4\times3=12$ sisters, and so on. The total number of combinations of boys and girls in a family of 5 children $=2^5=32$, which are distributed into six classes according to the familiar binomial fashion as above; these are shown in line (5). Multiplying each entry in (5) with that in the same column in (3) we obtain line (6), which shows that the total number of girls in the 32 families is 80 ($=2\frac{1}{2}\times16$, as it should be). Multiplying similarly the entries in (5) by those in (4) we obtain line (7), which shows that the 80 girls have between them 160 sisters; consequently each girl has on the average 2 sisters. This is identical with my $d-\frac{1}{2}$.

I have made similar calculations for values of $d=1$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$ (above), and 3. In each case the result is that a girl has on the average $d-\frac{1}{2}$ sisters. It may therefore be assumed that the reasoning by which I originally arrived at that deduction is correct.

Before concluding, I should like to direct attention to a slip of the pen in the last line but one of my memoir, which somehow escaped correction; the term $d=5$ should have been $2d=5$. The context corrects the mistake, which may nevertheless puzzle the reader for a while.

FRANCIS GALTON.

Mendel's Law.

IN his letter of last week detailing his most interesting experiments on cross-bred maize, Mr. R. H. Lock makes the following statement:—"I see from the published account of a recent discussion at the Cambridge meeting of the British Association that the facts of Mendelian segregation are still disputed by the biometric school of evolutionists." Now it is easy to make a general statement about some vaguely defined group of men, and I have no right to speak for biometricians as a body. But as inventor of the term *biometry*, I may perhaps be allowed to say what I understand by it as a science, and to restate what I said with some emphasis at the Cambridge meeting. Biometry is only the application of exact statistical methods to the problems of biology. It is no more pledged to one hypo-

thesis of heredity than to another, but it must be hostile to all treatment which uses statistics without observing the laws of statistical science. The criticism which has been published in *Biometrika* upon Mendelian work has attacked its too frequent want of method and of logic, and I think no one can have read recent literature without seeing that the criticism has been effective in its aim. Even Prof. Tschermak now allows a large influence to ancestry, although he asserts that the offspring are not distributed "in the proportions of Galton and Pearson." As I have never distributed the offspring in *fixed* proportions, I may perhaps be content with the admission.

I have headed my letter "Mendel's Law," but the difficulty is to know what is understood by this term. Mr. Lock reproves me in his "Studies in Plant Breeding in the Tropics" because I distinguished a theory of the pure gamete from pure Mendelianism, for I thought, and still think, Mendel himself considered "dominance" an essential part of his system. Another Mendelian protagonist, Prof. Castle, in his last paper writes:—"The basic principles of Mendel's law are two, the principle of dominance and the principle of segregation." Which view is the correct one? If Mendel's law be limited to its earliest form, then it may cover Mendel's own observations and Mr. Lock's maize, but there are many other cases of segregation which it does not cover. So far as I am aware, the only attempt to carry out any form of Mendelianism to its logical conclusion was produced by one biometrician at the suggestion of a second. I refer to my memoir in the *Phil. Trans.*—"A Generalised Theory of Alternative Inheritance with Special References to Mendel's Laws." Even then we did not succeed in making the fundamental hypotheses wide enough to cover the case of man, but we did show—what must be obvious on consideration—that a *description* by modern statistical methods of actual observations need not, as such, be itself opposed to any physiological hypothesis. Out of Mendelianism came on analysis the condemned "law of regression" and the diminishing correlations of the "ancestral law" whenever a population springing from hybrids mated at random.

One might at least have hoped that this result would have demonstrated how idle it is to contrast a school of "Mendelians" with one of "Ancestrians." It is, I fear, however, vain for the biometrician to try and right himself with the non-mathematically trained biologist. Notwithstanding that in every generation dealt with in my memoir the fundamental idea of Mendel is accepted and the recrossing of the parental forms with each member of the generation occurs and is treated as giving its Mendelian result, Mr. Lock in his "Studies in Plant Breeding" states that I entirely ignore Mendel's demonstration of the truth of his hypothesis by the process of recrossing with the parental form. The only ignoration seems to be one on Mr. Lock's part of what lies behind the mathematical symbols. What, then, is the Mendel's law for which Mr. Lock provides a "crucial experiment"? The mere fact of segregation? Two grey-eyed human parents will produce blue- and brown-eyed children; this has been long known, and is equally crucial. The segregation of *recessives* in certain cases in the proportion of a quarter? This is a fact, but, accepting the fact, is it needful to accept Mendel's theory to describe it? For Mr. Lock's maize, as for mice, we may fairly ask where the other homozygote is before we accept the experiments even as complete cases of the old simple Mendelianism. But Mr. Lock tells us that not even in 1900 did Mendelians suppose Mendel's law to hold good for all characters in all species. The experiment is therefore clearly not "crucial" for heredity at large. It is of interest, great interest, as adding to the number of things in which a Mendelian proportion of 1 in 4 holds for recessives. Will anyone explain why the absence of colour bulks at present so largely in the characters for which this proportion holds? There must be some physiological ground for it.

Karl Pearson.

The Formation of Polonium from Radium.

The idea has for some time been afloat that the polonium found in radio-active minerals is a product of the radium that they contain. I have recently made an experiment which seems to afford considerable evidence that this is the case. Some radium salt of quite low activity (barely sufficient to produce fluorescence), which has been in my possession four years or more, was dissolved in water, and some cupric chloride added. The solution was precipitated with sulphuretted hydrogen (the copper served to give a manageable quantity of precipitate).

The sulphide was very active. It was dissolved in nitric acid, and a plate of bismuth immersed in the solution, in order to collect polonium, after Marckwald. This plate became intensely active, giving α rays only. The activity was sufficient to light up a blende screen. The rays showed diminished penetrating power the further they had penetrated; their initial penetrating power was exactly the same as that of the rays of the polonium from pitchblende.

I think it will be agreed that the activity of this bismuth plate may be regarded as due to polonium. Its activity has not yet diminished. The question remains, was this polonium part of the original mineral, or has it been generated since? It is difficult to believe that the radiferous barium could have been freed from copper, bismuth, and the other metals in pitchblende, without being freed from polonium too.

I am making fresh experiments to see whether the formation of polonium can be traced in a radium solution initially quite free from it.

R. J. Strutt.

Terling Place, Witham, Essex.

Misuse of Words and Phrases.

Unfortunately a good style of writing English is not a strong point among men of science, especially mathematicians. The chief defects may, I think, be classed under three heads. First, grammatical errors, such as *Bessel functions, the Faraday effect, an uniform density* instead of *Bessel's functions, Faraday's effect* and *a uniform density*. Secondly, the use of uncouth, inelegant, and inaccurate phrases, such as *coal-stuff-gas, stretch-squeeze ratio, non-singular cubic or quartic curve*. Thirdly, a vague, obscure and slovenly mode of constructing sentences, whereby the author envelops his meaning in a cloud of mystery instead of enlightening the understanding of his readers. In fact, the sentences of some authors are so inartistically worded as to produce the impression that they labour under the delusion that a vague and obscure style of writing is evidence of profundity, whilst a clear and lucid one betokens shallowness.

The English language is by no means an easy one to write clearly and concisely, which is due to various causes, amongst which may be mentioned the absence of declensions. In Latin the nouns to which two pronouns respectively refer are always known if (as frequently happens) their genders are different; but in English considerable care is often required in the arrangement of a sentence so as to avoid ambiguity.

As regards the choice of language, there are two cardinal rules to be observed. In the first place, words are to be construed according to their natural and literal meaning unless there is something in the context to show that they are used in an artificial or secondary sense; secondly, lucidity and brevity ought always to be aimed at, and circumlocution and verbosity avoided.

October 22. A. B. Basset.

The British Association and Referees.

The correspondence in Nature some time ago respecting referees induces me to send you the following singular example of their unbusiness-like ways in the hope that greater care may be exercised in the future.

I submitted a radium paper to Section B for the Southport meeting. It was accepted; the usual proof was printed, revised by me and returned. *At* Southport it was decided by a joint committee of Sections A and B that the radium papers held by the latter should be handed over to Section A. This was done. It appears that my paper, now in new hands, was submitted to a referee and condemned. At the close of the meeting I was informed of the fact by the assistant general secretary. In the meantime, however, in reply to my personal inquiries, I had become acquainted with the state of things, and ventured partly to express my views on radio-activity at the discussion in Section A. In the sub-

sequent report of this discussion in your Journal these views were suppressed. The abstract of the rejected paper was printed in the annual report of the British Association, just issued, among the Section B papers, from the officers of which section I had received uniform courtesy and consideration throughout the transaction.

Now such a joint resolution as I have mentioned ought to have precluded any referee from rejecting a paper which had already been approved, and I have to suggest that a by-law be framed to render an occurrence of this kind impossible in the future. WILLIAM ACKROYD.

Striped Hawk-moths in Sligo.

THERE has been a letter or two in recent numbers of NATURE on the finding of rare moths in England. It may be of interest to the writers to know that in the middle of last September there was caught in the town of Sligo a specimen of the striped hawk-moth. It was captured in the printing office of the *Sligo Independent*, its great bulk first attracting attention and then its beautiful markings. I know but very little about insects, the honey bee excepted, but I carefully compared the living object with a description and coloured plate in a work on Lepidoptera, and have no doubt but that it was the very thing your correspondents are making so much ado about. It is now preserved in a little collection of Mr. Irvine (Ratcliffe Street), but the gorgeous colouring has all gone, and the striping is barely traceable. I have been told that another exactly similar moth was found last year a few miles from Sligo along the sea coast.

I never noticed one of these insects before, but if it be such a rarity in the British Isles as your correspondents seem to hold, it is easy enough to account for its presence in the present instance. Sligo is a sea-port town, and in August last a cargo of timber from, I was told, South America was discharged. Most likely the eggs came over in the timber and were here hatched out.

JOSEPH MEEHAN.

Creevelea, Drumkeeran, co. Leitrim.

THE SIMPLON TUNNEL.

AS the Simplon Tunnel is rapidly approaching completion, natural curiosity is aroused as to the extent to which the accuracy of the alignment has been attained. This is a riddle which can only be answered when the last metre of rock has been removed and the two headings unite.

It was hoped that this international meeting of Switzerland and Italy, under Mont Leone, would take place in October, but in consequence of unexpected difficulties which occurred early in September, it is probable that the actual junction will not occur so soon.

The setting out of the centre line of the tunnel is done every month by the company and contractors, but, in addition to this, the work is checked several times in the year by the Government engineers. On these occasions the work in the tunnel is entirely suspended, so as to ensure that the atmosphere for the entire length shall be bright and clear. A small slit of light is thrown into the tunnel by means of a powerful lamp, and by the aid of theodolites this is taken right up to the working face. It is anticipated that when the actual meeting occurs the error in level will be nil, and that the error in direction will be under eighteen inches.

As our readers know already, the length of the tunnel will be $12\frac{1}{4}$ miles, all of which has been penetrated with the exception of a short distance of about 260 yards near the middle. The work consists of two single line tunnels 50 feet apart, axis to axis, and the object of having two tunnels in place of one has been fully justified by later experience, and for the following reasons. The ventilation is much more efficient, one tunnel being used as an "intake" for fresh air, which is blown in by powerful high-speed fans working with a water-gauge of nearly 9 inches, the other being the outlet; in case of derailment of a train occurring it cannot possibly run into a train in the opposite direction; when repairs are required one tunnel can be closed for a time, the traffic being conducted in the other; and finally, which is most important, the crushing weight of the material overhead is much more easily dealt with than it would be in a double line tunnel. When it is remembered that the overlying rocks extend to a height of 7005 feet, and that the workmen are at the enormous distance of nearly $1\frac{1}{2}$ miles below the surface, or 50 per cent. more than man has ever been heretofore, it will be realised that not only is the pressure enormous, but the heat is also great; in fact, the pressure which has been encountered is so great that in one place the arching, consisting of granite blocks, is 2 metres in thickness. The tunnel is arched throughout, as it was deemed advisable that no risk should be incurred of even a

FIG. 1.—The Great Spring, 12,000 gallons per minute.

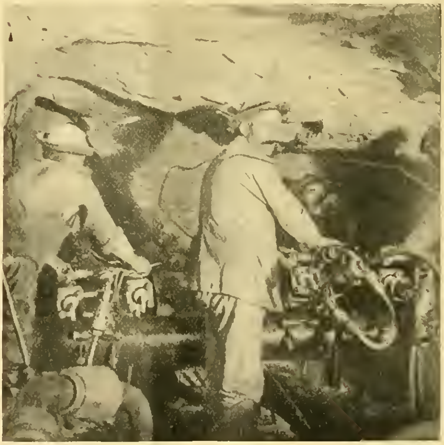


FIG. 2.—The Brandt drill at work at the "face." Daily progress 18 feet. Size of heading 10 feet × 6 feet.

small fragment of rock falling on to the permanent way.

In order that the present condition of the work may be better understood, a longitudinal section along the line of the tunnel is given, drawn to a small scale; and, with a view to illustrate the facts better, the gradient is very considerably exaggerated.

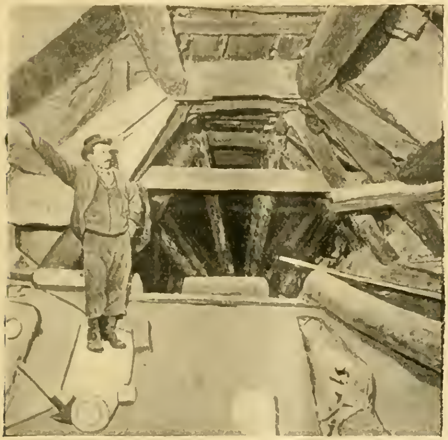


FIG. 3.—The timbering of the tunnel—six miles from the entrance.

It will be noticed that the gradient rises from each end of the tunnel towards the middle, the object of which has been to provide efficient drainage from the face, and it is an instance of the prudence which has been exemplified throughout the entire work that this system was adopted from the commencement. In driving a heading forward under a mountain, it is a matter of very common occurrence that springs of water are encountered; consequently, on the ascending gradient, the water flows away by gravity from the workmen; but should the work be carried out on a descending gradient, then the water accumulates where the men are working, not only causing them inconvenience and delay, but requiring to be pumped out over the highest point of the rails. In order to prevent delay, this was done for some considerable distance; but in consequence of a hot spring being encountered at the "face" on the Swiss side it was deemed necessary to withdraw the workmen, and the tunnel between points A and B has become filled with hot water.

At each end of the tunnel—Brigue at the north portal, and Iselle at the south or Italian entrance—a large and well equipped installation is provided for carrying on the works, and each of these is provided with machinery of sufficient capacity and power to serve for half the distance, that is, to the summit of the tunnel at A.

The work of actual perforation at Brigue and Iselle began in August, 1898, by hand, and by Brandt drill in December, 1898. When, however, the advance from the Italian entrance had reached a point between 15 and 16 kilometres, the great spring of 12,000 gallons per minute was encountered. This caused a delay of several months, thus throwing back the progress very considerably. In the meantime, the advance from Brigue proceeded rapidly, the summit A being reached in the month of December, 1903. Then arose the question, as already explained, in order to save time, of driving the tunnel downhill in order to meet the workmen coming up from Italy.

Meanwhile, the work on the Italian side has been pushed forward until the distance remaining to be pierced, as already mentioned, is only some 260 yards; but a serious difficulty has arisen, for again a hot spring has been encountered, and the temperature of the rock in the advance gallery is 108° F.

The system adopted for dealing with hot springs is very ingenious—and at the same time very simple. It was at first proposed to conduct the hot water out of the tunnel through pipes, but the simpler and more efficient method, which was adopted, is to play a jet of cold water into the fissure from which the hot water is escaping, and thus to cool it down to such a degree that the workmen are not seriously incommoded; they are then able to continue the drilling and blasting.

A channel or canal is being excavated at one side of the tunnel to carry the hot water from the spring to the outside, and this will be covered over with non-conducting material to prevent the heat rising into the tunnel.

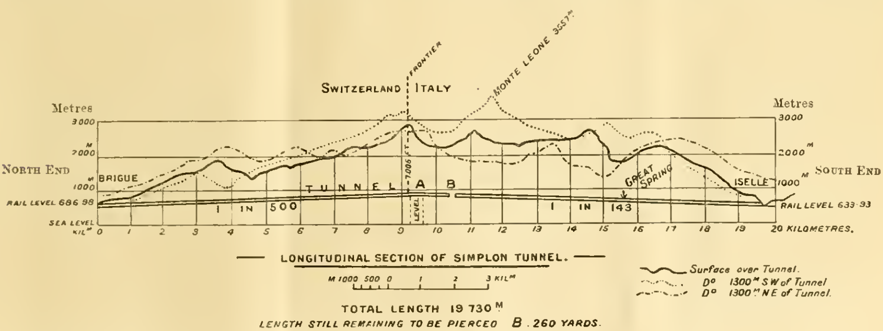


FIG. 4.—Longitudinal section of Simplon Tunnel.

The question arises from whence this great heat comes, for although observations made in various wells and borings in all parts of the world give an approximate figure of 1° F. rise in temperature for each 70 feet of vertical depth, this is insufficient to account for

what has been encountered, and one is driven to the conclusion that some portion of the thermal result is due to the internal heat of the earth arising from volcanic agency.

The energy and skill of those in control, amongst whom are Colonel Locher, Herrs Brandau, Pressel, Kager, Sulzer, and many others, are surmounting these difficulties, and it is anticipated that without any very great delay the junction of the headings will be effected.

Certainly no tunnelling operations in any part of the world have been exposed to such vicissitudes and difficulties, and when the arching of the tunnel is fully completed little will be left to show how hardly earned has been the victory over physical obstructions.

It is expected that within three months of the piercement trains will be running, and the railway will prove to be a most important link in the line of communication between Rome, Genoa, and Milan with Lausanne, Berne, and mid-Europe. FRANCIS FOX.

WATER-DROPPERS AND RADIUM COLLECTORS.

IT is more than forty years since Lord Kelvin commenced a new era in measurements of atmospheric electric potential by devising the water-dropper. Though marking a great advance, and simple in its construction, the water-dropper has not increased the happiness of those responsible for the conduct of self-recording meteorological instruments. It has weaknesses which it takes some time to discover, and which, when undetected, may lead to serious error. Some of the earlier forms had their water reservoirs so constructed that the pressure under which the jet issued varied considerably with the time since the reservoir was filled. Punctuality in filling the reservoir had in this case the disadvantage of accentuating a subsidiary diurnal variation not due to nature. The misdirected attention of spiders, variations of moisture, and other meteorological conditions, produce changes of insulation in the water tank; choking of the jet occasionally happens through impurities in the water, and in severe winters there may be complete stoppage through freezing of the jet. As this major catastrophe usually occurs at night, it generally entails a considerable loss of trace.

The idea of replacing the water jet by some radio-active substance presented itself pretty soon after the announcement of Becquerel's discoveries. The report of the International Meteorological Committee, which met at Southport in 1903, contains a note by Prof. Paulsen on his early use of a radio-active powder. This was spread on filter paper resting on a disc of copper, a thin covering plate of aluminium serving as a protection against rain. In this form the apparatus was used in Iceland in 1899–1900. M. La Cour modified this form by mixing the powder with caoutchouc into a paste, which was spread on a disc of copper, while a thin copper grating was pressed down on the top of the paste before it was quite dry. This form was used with satisfactory results in Finland in 1900–1. After wetting by rain, however, its efficiency was temporarily lessened. The same report also describes an instrument which M. Moureaux had had in use for some time at Parc St. Maur Observatory, Paris. It employs as collector chloride of radium in a shallow copper vessel, over which is soldered a plate of aluminium 0·1 mm. thick to keep out rain. Chloride possessing 5000 times the activity of uranium was not sensitive enough, but chloride with 30,000 times the activity of uranium gave good results. M. Moureaux so arranged matters that he could at pleasure record the electric potential, practically at a fixed point, either by the radium collector or a water jet. In this way he obtained an electrogram, successive portions of which were obtained in immediate sequence by the two collectors. Unless the times of the change had been indicated, one could not have told by inspection of the curve—which is reproduced in the report—which collector was being used. When M. Moureaux's note was written the radium had been in use for several months with satisfactory results. A foot-note, however, of later date, mentions that some months later the radium was found to have produced a number of minute holes in the aluminium, and that it was intended to dispense with the aluminium and protect the radium against rain by coatings of varnish. It was further hoped that this would admit of the use of cheaper chloride of less radio-activity.

The employment of radium is thus hardly out of the experimental stage, and any one adopting it at present would be well advised to check the action from time to time by recourse to a water jet. It would also be desirable to make sure before final adoption that the radium does not itself modify the potential which it is desired to record, more especially in calm weather. Whatever the final outcome may be, it is at least satisfactory that M. Moureaux's experiments showed agreement between the water jet and the radium collector when both were upon their good behaviour.

C. CHREE.

NOTES.

THE friends of Prof. G. Carey Foster, F.R.S., are taking the occasion of his recent retirement from the principalship of University College, London, as an opportunity of showing their appreciation of him by promoting a fund with the object of having his portrait painted for presentation to the council of the college, and a replica for presentation to Mrs. Foster. The president of the movement is the Right Hon. Lord Reay, G.C.S.I., and the vice-presidents are Sir Norman Lockyer, K.C.B., Sir Oliver Lodge, and Sir Arthur Rücker. Further information with regard to the scheme may be obtained from the secretaries of the fund, University College, Gower Street, W.C.

THE death is announced at Hamburg, on September 27, of Dr. H. Kortum, professor of mathematics at the technical college at Bonn.

THE Naples Academy of Physical and Mathematical Sciences offers prizes of 500 francs to the authors of the best papers in Latin, French, or Italian on the two following subjects: the processes of formation of urea in the animal organism, and the evolution of the ovaric ovum in the Selacii. The essays are to be sent in anonymously, bearing a motto, on or before June 30, 1905. The Padua Society of Encouragement offers, to Italian subjects only, two prizes of 5000 francs for an essay on the present state of the problem of electric traction on railways, and for a new method of diagnosing the disease of pellagra previous to its development. This competition closes on June 30, 1906.

A PETITION has been presented to His Majesty in Council asking for the grant of a charter of incorporation to the South African Philosophical Society under the name of "The Royal Society of South Africa."

MR. WILFRED MARK WEBB has accepted the honorary secretaryship of the Selborne Society.

THE death is announced of Dr. Tillaux, professor of surgery in the University of Paris, president of the Academy of Medicine, and Grand Officer of the Legion of Honour.

Dr. Doyen is stated by the Paris correspondent of the *Daily Chronicle* to have succeeded in isolating a micro-organism in cancer, and to have prepared a curative serum for the disease. It is proposed to institute a committee to investigate Dr. Doyen's claims and reputed cures.

An appeal to the Danish people was issued at Copenhagen on October 18 for contributions to defray the cost of a monument to the late Prof. Niels Finsen, the discoverer of the light cure, and also for the establishment of a fund to be devoted to scientific and humanitarian purposes in accordance with his wishes.

According to the *Daily Chronicle* of October 17, a specimen of the water-warbler (*Acrocephalus aquaticus*) has been taken at Clay-next-the-Sea, Norfolk. Up to the year 1894, at any rate, only three specimens of this warbler were definitely known to have been taken in Britain, one of these being now in the museum at Dover.

Mr. A. W. Itter informs the *Times* that while an artesian well was being sunk on his property near Aylesbury, at a depth approaching 500 feet, the whole tackle was blown out of the bore-hole, and after a " noise like thunder," lasting for several minutes, natural gas rushed out, and on being ignited burnt with a brilliant light. He states that when he wrote, on October 19, the gas had been issuing for forty-eight hours, and was still pouring out at a pressure of more than 50 lb. to the square inch.

The *Times* correspondent at Copenhagen reports that shocks of earthquake were felt at 11.15 a.m. on October 23 throughout the Scandinavian countries. Disturbances occurred almost simultaneously at Stockholm, Christiania, Gothenburg, the northern part of Jutland, Malmö, and Copenhagen. The severest shock was in the Danish town of Aalborg. The earthquake was felt at Skagen, Frederikshavn, Hjörring, and Brönderslev, and in the Island of Laesö, but no serious damage was done. Telegrams from Christiania show that there was a great panic in the city.

The British Fire Prevention Committee's programme for the new winter session, which has just commenced, includes the preparation and issue of a report on the great Baltimore conflagration. Further reports will be issued on various tests with sprinklers, lamps, and different forms of partitions. Arrangements are also being made for the organisation of branches of the committee in Canada, Australia, and New Zealand. The committee will assist in the preparation of the " International Technical Dictionary," which is being issued by the German Institution of Engineers, so far as technical terms regarding fire prevention are concerned.

Major Powell Cotton is about to start on another African expedition. The object of the journey, which is expected to occupy eighteen months, is to explore the extensive country lying between the Nile and the Zambesi. After investigating the Great Forest and the district to the west of Lake Kivu, the region to the west of Tanganyika will be traversed, and the expedition will then proceed south towards Katauga. Major Cotton expects to come out in British territory in Nyasaland, whence he will travel to the coast by the Zambesi. Every facility will be given to Major Cotton by the Belgian Government, and as he will travel the entire length of the Congo State, there is every reason to hope that much may be added to the knowledge of the natural history of this part of Africa.

A correspondent suggests a means of obviating, in the ordinary form of Atwood's machine, the difficulty that the acceleration of the moving system is not constant, but increases continuously as more and more of the string passes over the pulley to the descending side. He proposes to connect the masses on both sides of the pulley to an endless cord, and so to ensure that the total length of string remains the same throughout.

A report has been received from the members of the sleeping sickness expedition of the Liverpool School of Tropical Medicine. Writing from Lisala, on the Upper Congo, they state that they believe they are leaving the districts where sleeping sickness is rife. Investigations have been made into cattle disease in the Congo Free State, and measures have been devised which, it is hoped, will enable stock to be raised there without difficulty.

It is stated that craw-craw, a common skin affection on the west coast of Africa, has made its appearance in Birmingham. The disease is due to a nematode worm allied to the filaria, and it is reported that Mr. J. D. Whittles, lecturer on dental histology and pathology in the University of Birmingham, has detected the worm in the blood of several persons. Confirmation of this observation will be awaited with interest.

We have received the report of the Glasgow Municipal Commission on the Housing of the Poor. Among the many recommendations contained in it, one suggests that, with the view of encouraging private enterprise to erect suitable, sanitary, and cheap rented houses for the poorer classes, some relaxation of the provisions of the Building Regulations Act should be favourably considered by the corporation under proper safeguards.

In the *Scientific Memoirs of the Government of India* (No. 11) Lieut. Christophers, I.M.S., gives additional particulars respecting the Leishman-Donovan body or parasite (see Nature, vol. lxx. p. 534). He states that the bodies described by Wright in tropical ulcer are indistinguishable from those found in cases of enlarged spleen in Madras. The bodies may occur in the leucocytes in the peripheral blood, but have not been detected in the red blood cells.

The " General Report and Statistics of Mines and Quarries," part ii., for 1903, is in many respects interesting reading. The general death rate from accidents of those employed in coal and metalliferous mines shows a steady decrease, having fallen from an average of about 2·25 per thousand during the years 1873–82 to 1·25 per thousand during the years 1898–1903. On the other hand, in the Cornish mines, and probably elsewhere, the death rate from phthisis among men from twenty-five to forty-five has very greatly increased during the last few years, and is attributable to the use of rock drills, which cause much dust. Reference is also made to the outbreak of ankylostomiasis in the Cornish mines.

From Mr. J. Wheldon, of Great Queen Street, we have received a catalogue of books and papers on invertebrates (other than insects).

In the October number of *Nature Notes* the editor commences a series of papers on the geology of scenery, dealing in this instance with stratification.

According to the annual report for 1903–4, the rate of additions to the industrial section (inclusive of ethnology) of the Indian Museum, Calcutta, is such that it is increasingly difficult to find space for the accommodation of

the new specimens. The superintendent has to report the theft during the year of a quantity of gold jewellery, of which no trace has been discovered.

Zoological papers received from America in our last week's batch include a treatise on Acarina, or mites, by Mr. N. Banks; notes on Hawaiian reptiles, by Mr. R. C. McGregor; on reptiles from Missouri, by Mr. J. Hurter; two molluscan papers by Mr. F. C. Baker, and a third, by Mr. T. L. Casey, on the gastropods of the family Pleurotomatidæ. The first two are published in the *Proceedings* of the U.S. National Museum, the rest in the *Transactions* of the St. Louis Academy.

The *American Naturalist* for July and August contains a report of the proceedings of the first annual meeting of the eastern branch of the American Society of Zoologists, held in Philadelphia in December last. Of its other contents, perhaps the most interesting is a paper, illustrated with a coloured plate, by Mr. M. M. Mayland, on the colour-variation displayed by a small local form of the common marine gastropod *Neritina virginea*, which inhabits "Salt Pool," near Port Henderson, Jamaica, and is also found in a fresh-water stream in the same island. In the one instance the dwarfing is attributed to the extra salinity of the water, in the other to its freshness. The diversity in colour and colour-pattern of both the normal and the dwarf forms is extraordinary, and perhaps unparalleled, but all the variations intergrade.

Mr. H. Ingle, who recently went from the Yorkshire College to take charge of the chemical work of the Transvaal Department of Agriculture, contributes a short paper to the department's Journal on the composition of Transvaal soils. About a dozen typical soils from different parts of the country have been examined by him. He finds that, as compared with English soils, Transvaal soils are somewhat markedly deficient in nitrogen and phosphoric acid, but he very properly points out that their fertility cannot be judged of entirely by European standards. The soils are in reality much better than analyses made in the ordinary way would lead us to suppose. When Dyer's method was employed the proportion of available to total phosphoric acid and potash was found to be high, much higher than is usually the case in this country. As a set-off to the natural poverty of the soils in nitrogen, Mr. Ingle indicates that the receipts of combined nitrogen from the atmosphere are probably higher in South Africa than in England. In February and March of this year, for example, the rainfall collected in Pretoria brought down about 2 lb. combined nitrogen per acre, whereas at Rothamsted the average annual receipts of the soil from this source amount to some $4\frac{3}{4}$ lb. only. In addition to nitrogenous manures, Transvaal soils require compounds supplying phosphoric acid and lime, and of the manures imported basic slag is suggested as likely to be most economical.

As a contribution to the volume which was prepared in honour of Dr. P. Ascherson's seventieth birthday, Dr. Stapf has written a sketch of the distribution of the grasses in South Africa. Two main subdivisions are distinguished, a smaller group of forms extending into the tropics and a larger endemic South African group, which includes subtropical and temperate forms. The tropical and subtropical species are allied to the palæotropic flora of tropical Africa; the temperate element has affinities with some grasses of Asia Minor and Australia, but how and when they have been connected is not obvious. There is an accumulation of temperate grasses, many of them endemic species, in the Cape district, which suggests that the land formerly extended further south.

According to *Circulars* received, the Department of Agriculture in the United States, through the Bureau of Forestry, offers the services of its officers to farmers and landowners as advisers in the matter of tree planting and forest conservation. As for the conditions under which this help is given, preliminary examination is defrayed by the department, but if the undertaking is sufficiently extensive to require a survey and special plans, the owner has to pay actual and necessary expenses; the object is to prove to timber-land owners that conservative methods of lumbering will pay.

In the *Revue Scientifique* of October 1 Prof. A. Thauziès, of Périgueux, resumes the discussion of the question as to the manner in which carrier-pigeons find their way home. In the same journal for March 24, 1900, Mr. de Cyon expressed the opinion that the sense of smell determines the proper direction, and it is to the refutation of this theory that the portion of the professor's article published in the issue before us is devoted. Among other points cited to disprove the olfactory theory is the fact that young pigeons are frequently unable to discover the whereabouts of their dovecot despite the overpowering odour issuing therefrom. In the concluding portion of his *critique*, published in the issue of October 8, Prof. Thauziès discusses the theory that homing pigeons orientate by a "sense of attitude." That is to say, they preserve a sense of direction by the number of times they have turned *en route*. After urging several strong and apparently fatal objections against this theory, Prof. Thauziès suggests that it may nevertheless contain a germ of truth. For the present, however, the "homing instinct" must remain a puzzle.

The current number of the *Annals* of the Royal Botanic Gardens, Peradeniya, contains several papers of interest, and helps to emphasise the necessity for a thorough study of the problems presented by tropical vegetation. A paper by Mr. R. H. Lock is of particular value in this connection. By a careful study of the rate of growth of giant bamboos, Mr. Lock has found that the difference in rate of growth between day and night is due, not to the alternation of light and darkness, but to the change in the conditions of moisture, the air being damper at night. The curve of rate of growth follows that of moisture and rainfall with most surprising closeness. The second part of Mr. Herbert Wright's paper on Diospyros contains figures of the flowers, &c., in this genus, and shows the great need for study of tropical plants in the field as well as in the herbarium. The number also contains a paper by Dr. Svedelius on *Enalus acoroides*, the life-history of which he studied in the straits between Ceylon and India. The floral mechanism shows a very interesting difference from that of Vallisneria, correlated with the fact that Enalus is a marine plant. The male flowers are caught at low water and drawn under as the tide rises, pollination taking place subsequently. Another paper by Mr. R. H. Lock contains a preliminary statement of the results of the first "Mendelian" breeding work carried on in the tropics, and gives a number of interesting results with peas and maize, mentioned in last week's Nature (p. 601).

The report of the Meteorological Commission of Cape Colony for the year 1902 shows that the interest taken in the progress of meteorology by the public is increasing. Rainfall is observed at 500 stations; this number includes 58 second order (barometric) stations and 27 third order (thermometric) stations. The report also contains sum-

maries at a large number of stations in neighbouring colonies and in German South-West Africa. At the request of the Admiralty circulars were issued to all observers at second order stations south of 30° south latitude asking them to take observations at Greenwich noon, in connection with the National Antarctic Expedition.

The U.S. Hydrographic Office has issued a handy pamphlet of instructions, prepared by Mr. J. Page, for the use of the voluntary meteorological observers who contribute information for the U.S. Monthly Pilot Chart; it will also be found very useful for all observers at sea. The number of vessels regularly engaged in its service exceeds 1800, and the list embraces the merchant marine of all nations, all the vessels of the U.S. Navy, and many foreign cruisers. The form of weather-register now in use was adopted in 1888; it provides only for a single daily observation, to be made at Greenwich noon, instead of the old form recommended by the International Maritime Congress held at Brussels in 1853, which provided for observations at several hours. The registers are generally returned by post in a foolscap envelope at the end of each month, and supply the information required for laying down tracks of storms, and for the preparation of mean values for each month, published in the valuable monthly pilot charts, to which notice has frequently been directed in our columns.

An interesting article on the development of the theory of electrolytic dissociation is contributed to the *Popular Science Monthly* (September) by Prof. Svante Arrhenius.

In the *Transactions* of the Academy of Science of St. Louis, Prof. Francis E. Nipher discusses the speed of the trotting horse as a function of the time, and applies the empirical equation $s=a+be^{-kt}$ to connect the speed s with the time t in the problem or problems, of which he gives numerical illustrations.

In a short but suggestive paper contributed to the *Popular Science Monthly* (September), Dr. Allan McLaughlin discusses the problem of Hebrew, Magyar, and Levantine immigration. The first part deals with the persecution of the Jewish race in Europe, and the serious problem which America has to face in the building up of large ghettos in towns like New York by the overflowing stream of immigrants. Of the Magyar race only 27,124 subjects were landed in America in 1903, and these appear to be ideal immigrants but for their tendency to return to Europe. In regard to Levantine races, we are told that "the Greeks are the best of this rather bad lot."

Several interesting papers on radio-activity are contained in recent numbers of the *Atti dei Lincei* (xiii., 3, 4, 5). In the first of these numbers Drs. G. Martinelli and A. Sella give measurements of the radio-activity of the pozzolana from the neighbourhood of Rome. In the next Dr. G. Martinelli describes experiments to ascertain whether the reactions involving loss of weight (according to the theories of Landolt, Sanford, Ray, Heydweiller and others) are accompanied by radio-active phenomena. A figure is given of the apparatus, in which the reactions were produced inside a closed vessel in a dish placed under the electroscope; but though each experiment was continued for two hours no positive results were obtained. Lastly, Messrs. G. Pellini and M. Vaccari discuss the chemical actions produced by radium. They find that there are many chemical reactions produced by light on which radium has no effect, and that, as a general rule, the actions most affected are those provocated by ultra-violet light or Röntgen rays.

We have received a reprint of a paper by Prof. H. Geitel which is published in the *Jahrbuch der Radioaktivität und Elektronik* under the title "Elektrizitätszerstreuung und Radioaktivität." It forms a valuable summary of the development of the study of terrestrial electricity from the time of Coulomb to the present.

In No. 7 of the *Bulletin* of the Royal Academy of Belgium M. H. Gillot publishes an experimental investigation of the properties of mixtures of the sugars and of the polyhydric alcohols. Melting-point curves are given for binary mixtures of saccharose, lactose, glucose, mannitol, and dulcitol, which are of importance because they indicate the non-existence of isomorphism between these substances. On the other hand, the presence of more than one eutectic point in many of the curves probably means that in these cases definite compounds are produced.

A prospectus has been issued by the Berlin Wireless Telegraphy Company, "System Telefunken," which describes the organisation and scope of the company and the character of the apparatus covered by its patents. The company is an amalgamation of Messrs. Siemens and Halske and the Allgemeine Elektricitats-gesellschaft of Berlin, and its system a combination of the Braun-Siemens and the Slaby-Arco systems. The company has already equipped more than fifty German warships with its appliances, and its system has been adopted by the United States Navy. An especial feature of the prospectus, which is excellently illustrated, is the description of a portable apparatus designed for military field service. The transmitter and receiver are arranged so that a variation of several hundred per cent. in the wave-length of the electric waves can be rapidly made; in this manner disturbances caused by the enemy may be eliminated.

Mr. H. J. Glaisher, of Wigmore Street, will shortly publish "X-Rays: their Treatment in Cancer and other Diseases," by Mr. R. J. Cowen.

Prof. Meldola has completed vol. i. of "The Chemical Synthesis of Vital Products and the Inter-relations between Organic Compounds," which is to be published by Mr. Edward Arnold on November 1.

The syllabus of meetings for the session 1904–5 of the Hampstead Scientific Society gives full particulars of the subjects for the general meetings and for the separate meetings of the natural history, photographic, and astronomical sections.

A new edition of Mr. Joseph Y. Bergen's "Elements of Botany" has been published by Messrs. Ginn and Company. A more careful study has been made in this edition of typical cryptogamic forms, and an outline of the ecological classification of plants has been added, as well as chapters on the ecology of leaves and the evolutionary history of plants.

Messrs. Heffer and Sons, Cambridge, have in the press a book by Mr. S. W. Cole entitled "Exercises in Practical Physiological Chemistry." The book, which is written for the use of medical students, is essentially a laboratory book, only those exercises being included which the author has found can be carried through in ordinary class work.

Mr. W. B. Clive has published a revised and rewritten edition of "First Stage Magnetism and Electricity," by Dr. R. H. Jude. The section dealing with electrostatics has been curtailed and simplified, and a more practical

character given to the part on voltaic electricity. Under magnetism a brief account has been included of tubes of force, magnetic flux, permeability, and reluctance.

NEW editions of three standard works on botany have just reached us from Germany. One volume is the third edition of Prof. G. Haberlandt's "Physiologische Pflanzenanatomie" (Leipzig: W. Engelmann), the second edition of which was reviewed in NATURE of March 18, 1897 (vol. lv. p. 457). About sixty pages have been added to the work, and the number of figures has been increased from 235 to 264. Mr. Engelmann has also published the twelfth edition of Prantl's "Lehrbuch der Botanik," revised by Prof. F. Pax. The additional matter has enlarged the book by twenty-two pages, and twenty-five new figures have been included. The fourth revised edition of Prof. A. Engler's "Syllabus der Pflanzenfamilien" has been issued by the firm of Borntraeger Bros., Berlin. The work is a summary of systematic botany, with special reference to medicinal and useful plants, and a survey of kingdoms and regions of flowering plants; it is of particular value to students of special and pharmaceutical botany.

OUR ASTRONOMICAL COLUMN.

A NEW VARIABLE STAR.—A telegram received at the Kiel Centralstelle from Prof. E. C. Pickering, on October 7, states that the object discovered by Mr. Stanley Williams on September 20 is, according to its spectrum, a long period variable star.

On a plate obtained by Herr P. Gotz at Heidelberg on August 8·4 the star was fainter than B.D. $+29°·4653$, which has a magnitude of 9·2 (*Astronomische Nachrichten*, No. 3971).

EPHEMERIS FOR TEMPEL'S SECOND COMET.—In No. 3971 of the *Astronomische Nachrichten* M. J. Coniel publishes a continuation of his daily ephemeris for Tempel's second comet, extending from October 25 to January 1.

Abstracts of the previous portions have already appeared in these columns, and the following is from the present publication:—

Ephemeris 12h. (M.T. Paris).

1904	α app. h. m. s.	δ app. ° ′	log. Δ	$1 : r^2\Delta^2$
Oct. 25	17 25 44	−22 11	0·2584	0·156
,, 29	17 39 37	−22 50	0·2608	0·155
,, 31	17 46 40	−23 8	0·2621	—
Nov. 2	17 53 46	−23 25	0·2634	0·154
,, 4	18 0 57	−23 40	0·2648	—
,, 6	18 8 11	−23 54	0·2662	0·152
,, 8	18 15 29	−24 6	0·2677	—
,, 10	18 22 49	−24 17	0·2692	0·150

Although the comet was unsuccessfully sought during August and September, and, theoretically, its light should commence to diminish towards the end of the present month, the fact that at previous apparitions the light has been sensibly stronger after perihelion than before leads M. Coniel to hope that the object may yet be observed during its present return. As before mentioned in these columns, the feeble light of the comet, combined with its southerly declination, will render it a difficult object for observers in the northern hemisphere.

PHŒBE: SATURN'S NINTH SATELLITE.—The promised extended discussion of the observations of Phœbe by Prof. W. H. Pickering appears in No. 3, vol. liii., of the Harvard College Observatory *Annals*.

The discoverer of the satellite therein describes the first discovery of, and the subsequent searchings for, the object, explaining in detail the examination of the plates and the difficulties experienced in recognising the satellite's image.

Sixty photographs of Saturn have, so far, been obtained with the Bruce telescope, and of these twelve were taken when the planet was moving rapidly, and were therefore useless in locating the satellite's position. Several others were, for various reasons, useless, but the object sought is to be seen on forty-two plates, which are used in the discussion.

After preparing the description of the observations and results for the press, Prof. Pickering received information from Arequipa which considerably modified his ideas of the satellite's orbit. An approximate ephemeris had been sent to Prof. Bailey, at Arequipa, in March of this year, but he was unable to find the image of the satellite in the computed positions. Subsequent research has shown that the motion of this body in its orbit is probably retrograde, an unlooked-for possibility, since the other eight of Saturn's satellites all have direct motions. Consequently Prof. Pickering gives the details of the reductions for both retrograde and direct motion.

The elements, as determined for the case of retrograde motion, are as follow:—

Semi-major axis at a distance of 10 units measures 29′·62. This corresponds to a distance of 0·0862 astronomical unit, or 7,996,000 miles.

Eccentricity	= 0·22
Inclination to ecliptic	= 5°·1
Longitude of ascending node	= 220°
,, ,, perisaturnium ..	= 289°·7
Epoch of perisaturnium ...	= 1900 Mar. 28·0 (G.M.T.)
Period	= 546·5 days.

The inclination of the orbit of Phœbe to that of Saturn is, therefore, 6°·0, and the longitude of the ascending node is 170°·0.

The eccentricity is remarkable as being greater than that of any other satellite or major planet in the solar system.

The brightness of Phœbe is judged as two magnitudes fainter than that of Hyperion, which is assumed to be of the fourteenth magnitude. From photometric considerations the diameter of the satellite is thought to be about 200 miles.

In conclusion, Prof. Pickering gives a table showing the differences between the computed and the observed places of the satellite, and then discusses the deviations and gives an ephemeris for 1904.

FAINT STARS NEAR THE TRAPEZIUM IN THE ORION NEBULA.—The lists of stars in the Orion nebula recently published by Profs. Wolf and Pickering included none of the stars near the Trapezium, because, with the short-focus cameras used in obtaining their plates, the images of the stars in that region were blotted out by the bright nebula.

On the plates obtained by Prof. Ritchey in 1900 and 1901, using the Yerkes 40-inch telescope with a yellow screen placed immediately in front of the plate, these fainter stars are easily seen, therefore Mr. J. A. Parkhurst has measured their coordinates from θ' Orionis, and gives these, together with the magnitudes of the stars, in a list published in the September number of the *Astrophysical Journal*. The list contains forty-two stars, all within two minutes of arc of the trapezium star θ' Orionis, of which twenty-three were observed visually by Bond—these include ten observed photographically by Prof. Pickering—whilst nineteen are presumably catalogued for the first time.

PHOTOGRAPHIC DETERMINATION OF PARALLAX.—Encouraged by the successful photographs obtained by Prof. Ritchey with the Yerkes 40-inch telescope, Mr. Frank Schlesinger tried several exposures with the same instrument for the determination of several stellar parallaxes. The yellow screen used in the former work was found to be unnecessary, and, as it introduced several troublesome errors, it was dispensed with.

The great focal length of the instrument renders errors in measuring the plates much less important than when smaller instruments, such as those used in the production of the astrographic chart, are used, and Mr. Schlesinger computes the probable error for one exposure to be only $\pm 0''·030$.

Among the results obtained there occurs the parallax of the star *Krueger* 60 (R.A. = 22h. 24m., dec. = $+57°$ 10′), which was placed on the working list because Prof. Barnard suggested that it has a large parallax. The result shows that the suggestion is probably correct, and, if confirmed by other measures, it places the star as one of our nearest neighbours, its parallax being $+0''·278$. This value was obtained as the result of measuring eight plates, containing twenty exposures, and using five comparison stars (*Astrophysical Journal*, No. 2, vol. xx.).

THE CLASSIFICATION OF THE STARS ACCORDING TO THEIR TEMPERATURE AND CHEMISTRY.[1]

II.

THE temperature relationships of the various groups in the classification of stars described in the previous article are further illustrated in a diagram which is reproduced in Fig. 6, from which it will be seen that the stars

Highest temperature.

	Increasing temperature.		Decreasing temperature.
10		Argonian	
9		Alnitamian	
		Proto-hydrogen Stars	
8	Crucian	Cleveite-gas Stars	Achernian
7	Taurian		Algolian
6	Rigelian		Markabian
5	Cygnian	Proto-metallic Stars	—
4	—		Sirian
3	Polarian		Procyonian
2	Aldebarian	Metallic Stars	Arcturian
1	Antarian	Stars with fluted spectra	Piscian

FIG. 6.—Temperature relationship of stellar groups.

are arranged in sixteen groups along a temperature curve having its apex in the middle. Apart from the inferences as to low temperature which may be drawn from the occurrence of flutings, it will be remembered that while the evidence for temperature was primarily based on the strength of the continuous radiation in the violet, this detailed arrangement of the stellar groups depended upon the chemical sequence revealed by the successive predominance of metallic, proto-metallic, and "gaseous" lines in the different stars.

This chemical sequence, however, so far as could be judged from the photographs then available, was identical with that derived from the investigation of the violet radiation, thus showing that the apparent chemical differences resulted from changes of temperature. The simplest explanation of the chemical changes is that afforded by the dissociation hypothesis, according to which the step from metallic to proto-metallic vapours is to be regarded as a breaking up of complex molecular groupings into simpler ones still retaining characteristics which permit the parent substance to be distinguished, while the continuation of the process results in the reduction of all substances to the finer forms of hydrogen and helium. The classification of the stars on a temperature basis is therefore of the utmost importance, not only for the indications which it gives as to the processes of stellar evolution, but also on account of the light which it throws on the dissociation hypothesis and the evolution of the chemical elements. Adopting the foregoing temperature sequence of the various stellar groups, this side of the question has already been fully dealt with by Sir Norman Lockyer in his work on "Inorganic Evolution" (Macmillan and Co., Ltd., 1900).

[1] Continued from p. 614

In view of the important issues depending upon the correct determination of relative stellar temperatures, Sir Norman Lockyer has endeavoured to confirm his previous results by another piece of work, of which an account was recently communicated to the Royal Society.[1] The previous conclusions involving the intensity of the violet radiations depended upon photographs taken with optical appliances composed of glass, which has a marked absorption for these rays, and the relative intensities were judged by noting the limits of the spectra in photographs which were of the same intensity in the region about $H\gamma$. Although there was no reason to suppose that the general laws of continuous radiation would be modified in still more refrangible parts of the spectrum, it was possible to test the results further by including this region in the discussion. An instrument which was transparent to the ultra-violet radiations was necessary for this research, and the one devised for the purpose was a prismatic camera having a 2-inch 30° calcite prism mounted in front of a $2\frac{1}{2}$-inch quartz lens of 18 inches focal length (Fig. 7). The prism is so cut that its first face is perpendicular to the optic axis of the crystal, and it is so arranged that the incident rays are normal to this face. All the rays, therefore, pass through the prism parallel to the optic axis, and there is consequently no double refraction.

By this means it became possible to utilise not only the length of the spectrum in the violet, but the relative brightness of the different parts to a greater extent than before.

To make the matter clear, it may be pointed out that the temperatures of most of the stars are too high to permit of their determination from the actual limits of the continuous radiations towards the violet, as might conceivably be done in the case of a red-hot poker, since these limits lie beyond the wave-length for which our atmosphere is transparent. The principle involved in the method employed, however, is clearly indicated by Sir Norman Lockyer in a quotation from Sir George Stokes,[2] the substance of which has been fully borne out by more recent work, namely, that

"When a solid body such as a platinum wire, traversed by a voltaic current, is heated to incandescence, we know that as the temperature increases, not only does the radiation of each particular refrangibility absolutely increase, but the proportion of the radiations of the different refrangibilities is changed, the proportion of the higher to the lower increasing with the temperature."

In the case of stars, the radiation is of course modified by the continuous absorption of the stellar gases and vapours; but, so far as we know, the greater absorption is always associated with reduced temperature[3] and increased density, and regularly diminishes in intensity from the ultra-violet towards the red.

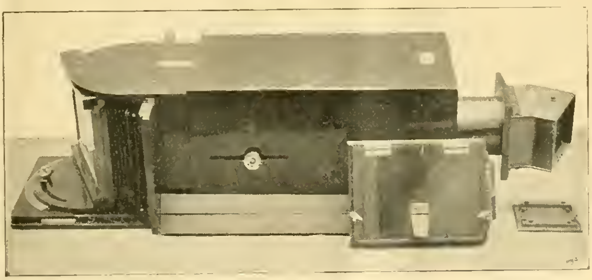


FIG. 7.—Quartz-Calcite Prismatic Camera.

Conclusions as to the temperatures of the stars, as was suggested by Crova in 1878,[4] may therefore be based on

[1] Roy. Soc. *Proc.*, vol. lxxiii. p. 227 (1904).
[2] Roy. Soc. *Proc.*, vol. xxiv p. 353 (1876).
[3] It has been observed that various metals, including iron, produce a continuous absorption at the blue end of the spectrum when reduced to the state of vapour in the relatively cool oxy-hydrogen flame (Lockyer and Roberts-Austen, Roy. Soc. *Proc*, vol. xxiii. p. 344, 1875).
[4] *Comptes rendus*, vol. xvii. p. 981.

the relative intensities of different parts of the continuous spectrum. While this was in reality what had already been done in the case of spectra photographed with glass prisms, the new apparatus permitted comparisons over a much longer range. In each case the limits of the spectra towards the ultra-violet in the photographs are determined by the intensities of the spectra in that region and the duration of the exposures.

To eliminate as far as possible the varying effects of atmospheric absorption, to which the ultra-violet rays are specially sensitive, and the errors which might arise from differences in photographic treatment, each selected pair of stars was photographed on the same plate when the stars had approximately the same altitude, and if any change in the atmospheric conditions were suspected the result was discarded. In each case an attempt was made so to expose the photographs that in every pair the intensity of the spectrum was as nearly as possible the same in both stars in the region between $H\beta$ and $H\gamma$. This condition was very difficult to fulfil in actual practice, owing to the different magnitudes and declinations of the stars compared, and the consequent need for very careful adjustment of the clock rate. The difficulty was further increased on account of the different actinism of the stars in this part of the spectrum. The work, however, has resulted in a series of comparison photographs from which all variable conditions except the natural variations in radiation have, so far as possible, been less extended towards the ultra-violet than that of η Ursæ Majoris, and the maximum intensity is much nearer the red end.

The general result of this research is thus stated:—"Taking the stars assumed to be hottest in the chemical classification, we find that in all cases the relative length of the spectrum is reduced, and the relative intensity of the red is increased, as a lower temperature is reached. That is to say that where two spectra having their intensities about the region $H\beta$–$H\gamma$ equal are compared, we find that in the cooler stars, according to the chemical classification, the emissions in the red preponderate, whilst in the hotter star the ultra-violet is more extended and intense."

In other words, the sequence of the various groups of stars, as determined by this more extended study of the continuous radiations, so far as the investigation has yet been carried, is identical with that previously arrived at from a discussion of the line spectra. It follows, therefore, that the classification which was based upon the chemical differences indicated by the successive appearances of metallic, proto-metallic, and gaseous lines, in all probability reveals also the true temperature sequence of the different varieties of stars.

As pointed out by Sir Norman Lockyer, this result is at variance with that arrived at by Sir William and Lady Huggins. While also basing their conclusions as to relative stellar temperatures on the comparative intensities

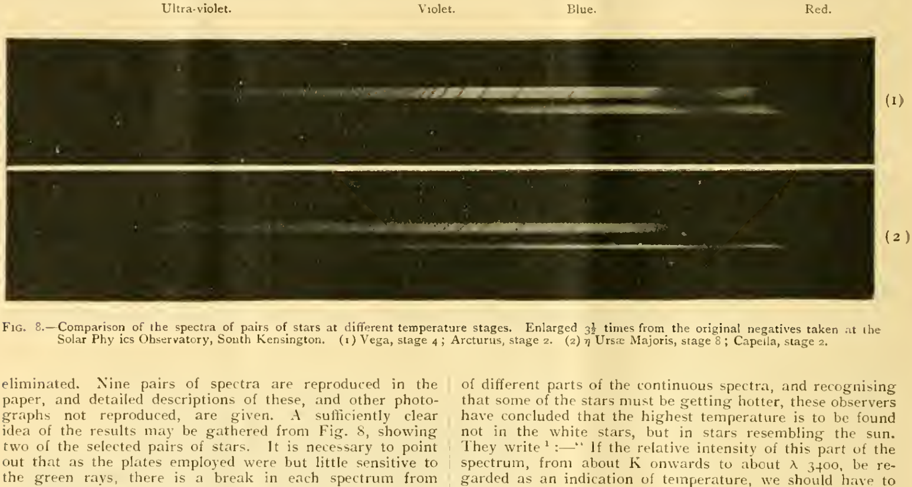


FIG. 8.—Comparison of the spectra of pairs of stars at different temperature stages. Enlarged $3\frac{1}{2}$ times from the original negatives taken at the Solar Phy ics Observatory, South Kensington. (1) Vega, stage 4; Arcturus, stage 2. (2) η Ursæ Majoris, stage 8; Capella, stage 2.

eliminated. Nine pairs of spectra are reproduced in the paper, and detailed descriptions of these, and other photographs not reproduced, are given. A sufficiently clear idea of the results may be gathered from Fig. 8, showing two of the selected pairs of stars. It is necessary to point out that as the plates employed were but little sensitive to the green rays, there is a break in each spectrum from about λ 486 to λ 550, followed on the less refrangible side by a further portion of the spectrum having its centre about "D." The numbered "stages" in the description refer to the ten horizons of mean temperature already shown in Fig. 6, stage 1 corresponding to the fluted spectra of the Antarian and Piscian stars, and stage 10 to the simplified spectra of the γ Argus type.

A glance at the photographs will suffice to show that in the case of each pair the star at the higher stage of temperature, as previously determined from the investigation of the line spectra, has the greater development of the violet end of the spectrum, and that the difference is more marked the greater the temperature difference. In the first example it will be seen that, while the maximum intensity of the spectrum of Vega is in the blue, that of Arcturus is obviously much further towards the red end; the differences at the extremities of the spectrum are also very marked, Vega having the greater extension into the ultra-violet, and a relatively reduced intensity at the red end as compared with Arcturus. Again, in the second pair, in spite of relative over exposure, the spectrum of Capella is notably of different parts of the continuous spectra, and recognising that some of the stars must be getting hotter, these observers have concluded that the highest temperature is to be found not in the white stars, but in stars resembling the sun. They write[1]:—"If the relative intensity of this part of the spectrum, from about K onwards to about λ 3400, be regarded as an indication of temperature, we should have to consider Procyon as at a hotter stage than Vega, and that the highest stage of temperature is reached in the true solar stage, of which Capella is typical. Then a fall of temperature sets in, as is shown in the advancing enfeeblement of this part of the spectrum in Arcturus, Betelgeuse, and Aldebaran." Special stress is laid by these observers on "the rather sudden fall of intensity of the continuous spectrum at about the place of the end of the series of dark hydrogen lines" in such stars as Vega (a feature which is well brought out in the photograph of the spectrum of this star reproduced in Fig. 8), but Sir Norman Lockyer states that this in no way affects his results, and promises another paper dealing with this and similar points. The precautions taken by Sir Norman Lockyer to secure equal treatment for the stars compared would seem to give his results greater weight than those of the other observers, whose photographs appear to have been obtained in the course of more or less routine work on the spectra of individual stars.

It should also be noted that the occurrence of proto-metallic lines has not been accepted as evidence of the

[1] "Atlas of Representative Stellar Spectra," p. 85.

relatively high temperature of a star by some observers, in consequence of the production of these lines in arc spectra under certain special conditions. The recent work of Mr. C. de Watteville[1] on flame spectra in relation to spark spectra obtained with and without self-induction, however, appears to be entirely in harmony with the result derived from stellar inquiries by Sir Norman Lockyer.

At present, then, the evidence available appears to favour the view that the chemical differences indicated in the different groups of stars are due to differences of temperature, and that successively higher stages of heat are indicated by the predominance of metallic, proto-metallic, and gaseous lines. Thus, although further researches on some points are needed, it is very probable that the new classification correctly exhibits the relative temperatures of the various stellar groups, besides giving exhaustive definitions and providing a convenient nomenclature. At the same time, the sequence of phenomena indicated in the classification seems strongly to support the dissociation hypothesis. A. FOWLER.

THE FALKLAND ISLANDS AND THEIR FAUNA.

MR. RUPERT VALLENTIN, who has spent many years in the Falklands, where he has been an assiduous observer and collector of the fauna and flora, contributes an excellent account, illustrated by photographs, of those remote islands to the third part of vol. xlviii. of the *Memoirs* of the Manchester Literary and Philosophical Society, of which his article forms No. 23. The author alludes in the first place to the celebrated stone-rivers, which consist of slowly moving blocks of quartzite between banks of peat. In Mr. Vallentin's opinion the stones forming these "rivers" had approximately attained their present position before the formation of the peat, and the "rivers" have been produced by the denudation of the peat. In every "stone-river" islets of vegetation remain near the margins, these being most luxurious where the denudation has been recent. Where the denudation is of long standing, the sole remnant of the covering of vegetation is a mass of bog-balsam (*Bolax globaria*), as shown in Fig. 1, which, owing to its long tapering root, can obtain nourishment after the soil which supported other plants has been washed away. Very similar "stone-rivers" exist in parts of the Himalaya.

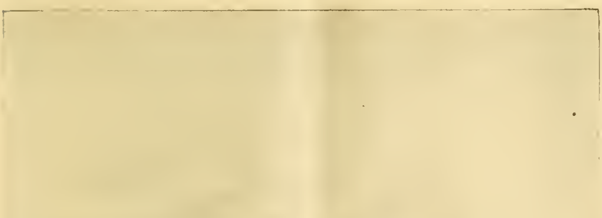


FIG. 1.—A mass of Bog-balsam near the edge of a Stone-river in the Falklands.

Apparently the Falklands are by no means the desolate spots we are often prone to imagine, the vegetation being locally abundant, and the shores of the estuaries and coves on part of West Falkland being fringed with bushes of the attractive Falkland box (*Veronica decurrata*), which has a beautiful and highly scented flower. With the aid of abundant manure, many English vegetables can be grown in sheltered spots.

FIG. 2.—Gentu Penguins on the Falklands. The birds in the background are running to the shore.

With regard to the fauna, the most interesting statement is the one to the effect that, so far as the author could ascertain, the Falkland Island wolf (*Canis antarcticus*) is now completely exterminated. This latest addition to the list of animals extirpated in recent years by human agency is the more to be regretted seeing that this wolf, or fox as it used to be called by the settlers, is an extremely interesting animal from the point of view of geographical distribution, and one that is probably very insufficiently represented in our museums. According to Prof. Huxley's paper on the dentition of the Canidæ, published in the Zoological Society's *Proceedings* for 1880, the Falkland Island wolf is closely allied to the North American coyote, the remarkable feature connected with this resemblance being that there are no true wolves in either Central or South America. The British Museum has one mounted skin of the Antarctic wolf in the exhibition galleries, and there are two skeletons in the store collection. Strychnine poisoning appears to have brought about the extermination of this wolf, the last survivor of which seems to have been killed so long ago as 1876.

Birds form by far the most important portion of the terrestrial vertebrate fauna of the Falklands, and among these penguins, of three species, and "mollymauks," or lesser albatrosses, are numerically the most abundant. Mr.

[1] Roy. Soc. *Proc.*, vol. lxxiv. p. 85 (1904).

Vallentin's article is illustrated by a photograph of a "rookery" of rock-hopper penguins (*Eudyptes chrysocome*), showing the myriads in which these birds congregate on the coasts, and by a second (herewith reproduced) of a much smaller assemblage of gentu penguins (*Pygosceles taeniata*). An interesting fact in connection with the habits of the rock-hoppers is that the smooth surfaces of the hard igneous rock over which these penguins have passed for generations are not only highly polished, but are marked by irregular groovings made by their claws. These scratches are usually about 3 inches in length, and may be as much as a quarter of an inch in depth. Apparently such a polished and striated rock-surface might well be attributed to ice-action. A striking feature about such a rookery is the number of dying and maimed birds to be met with; such injuries appear to have been inflicted by seals or sea-lions. The enormous number in which the "mollymauks" frequent the Falkland and other Antarctic islands may be inferred from the statement that on one occasion a vessel arrived at the main port with a cargo of 10,000 eggs of this species. Mr. Vallentin found these beautiful birds so tame and confiding that they allowed themselves to be stroked by his hand as he admired the softness of their plumage and its spotless condition. How these birds keep themselves clean amid the liquid filth of a rookery is little short of a marvel. R. L.

THE ST. LOUIS INTERNATIONAL ELECTRICAL CONGRESS.

THIS congress, during its five working days, considered about 160 papers on electrical subjects. In fact, so large was the number of papers and so wide the range of subjects of which they treated, that it may be said that there is no branch of electrical science which was not referred to at one time or another during the meetings. Nevertheless, the chief scientific interest in the proceedings centred round a few subjects, namely, units and standards, radio-activity, wireless telegraphy, and the electric arc. Of the engineering papers, those on the alternating current motor, the steam turbine, and high tension transmission attracted most attention. There were also numerous papers on electrochemical and electrotherapeutical subjects, which will not be referred to here.

The joint discussion by Section A, general theory, and Section B, general applications, on units and standards was opened with papers by Prof. Ascoli (systems of electric units), Profs. Carhart and Patterson (absolute value of the E.M.F. of Clark and Weston cells), and Dr. Wolff (international electric units). The subject divided itself into two parts:—(1) the true value of the volt and ampere; (2) which of these should be represented by a material standard, and the nature of that standard. During the discussions the naming of the magnetic units was also considered.

Upon the question of the true value of the volt and ampere there was practical unanimity of opinion that the true value of the volt (10^8 C.G.S. units) is such that the E.M.F. of a standard Clark cell at 15° C. is very much nearer 1·433 volts than 1.434, the present legal value. Profs. Carhart and Patterson, in describing the dynamometer with which they are making a re-determination of the ampere, stated that though the experiments were not sufficiently advanced to give a definite value, the results so far obtained made the E.M.F. of the Clark cell about 1.433 volts, accepting the ohm as correct. In this connection Mr. Trotter's results, mentioned by Dr. Glazebrook, are of great interest. Mr. Trotter has recently made a determination of the E.M.F. of the Clark cell at the Board of Trade laboratory in terms of the standard ampere and standard ohm, and finds the value to be 1·4329 volts at 15° C. It would thus appear that the voltage of a normal Clark cell, determined in terms of our standard ampere and ohm, is nearly 1/10 of 1 per cent. less than the legalised value. The Reichsanstalt take the value of the Clark cell at 1·4328 volts. It is of interest to note that the present legal value of 1·434 appears to be almost exactly correct at 14° C. instead of 15° C.

Mr. Barnes, in his paper on the mechanical equivalent of heat measured by electrical means, which contains a very careful comparison of the results obtained both by the electrical and mechanical methods, takes the Clark cell as 1·43325 volts, and then finds that the "results by the *continuous* electrical method is brought into absolute agreement with the *mean* of the mechanical measurements," and he gives the value of the mechanical equivalent as 4·186 joules in terms of the mean calorie between 0° and 100°.

The standards which are to represent the fundamental electrical units raised quite another set of questions, the main desiderata for these standards being that they should be both permanent and reproducible to a high degree of accuracy. No one appeared anxious to quarrel in any way with the standard mercury ohm, and the agreement of the standards lately made by the National Physical Laboratory, both with one another and with those constructed by the Reichsanstalt, shows that this standard is reproducible to a few parts in 100,000. Accepting the present ohm standard, it is only necessary to legalise a standard for either the ampere or the ohm, as the three units are connected by Ohm's law. Prof. Carhart and Dr. Wolff urged the desirability of defining the volt in terms of a cell, preferably the cadmium cell, and the ampere in terms of the volt and ohm, the advantages being that the standard cell is very generally used in practical measurements both of potential difference and current, and that the cells are reproducible to a high degree of accuracy. Dr. Glazebrook pointed out that the greater simplicity of the chemical changes in the deposition of silver gave promise of its being an even more accurate standard for the ampere.

Prof. Carhart and Mr. Hulett, in their paper on a study of the materials used in standard cells and their preparation, trace the difficulties with cells both of the Clark and Weston (cadmium) type to the mercurous sulphate; they describe an electrolytic method of preparing it, and they strongly emphasise the importance of avoiding hydrolysis of the mercurous sulphate. In a table in the paper they give the results obtained with fourteen cadmium cells made according to their method, from which it appears that the maximum difference between the voltages of individual cells and between the voltages of the cells during the whole seven months that the tests lasted did not exceed 5 parts in 100,000, so that, taking any cell at any time during the tests, its voltage could be depended on to within $\pm 0·03$ millivolt of the mean voltage. Similar excellent results have been obtained by Mr. Smith at the National Physical Laboratory (report to British Association, Cambridge).

In view of the large amount of work which is now being carried out on the preparation of standard cells and the redetermination of the ampere, the general feeling of the meeting seemed to be that international action to correct the error in the volt should be postponed, although one speaker urged that the error of 0.1 per cent. in the volt had become of serious commercial importance in the life tests of incandescent lamps.

Prof. Wolff's paper, which dealt largely with the legal definitions of the fundamental units adopted by various nations, pointed out the great differences which exist, and the necessity of rendering them all uniform.

On the subject of naming the magnetic units there was very little discussion; the question of 4π, of course, came up, and was discreetly left on one side, most of the meeting agreeing with Dr. Kennelly that it is better to let well alone, and that no very great practical advantage would result from the change. The views of the I.E.E. delegates, that if any magnetic units were named they should be those proposed by Dr. Kennelly, viz. the C.G.S. units of magnetic potential (already called the Maxwell at the Paris congress), total magnetic flux, and magnetic reluctance, met with pretty general acceptance. The other proposal made by Dr. Kennelly, namely, to add the prefix "ab" or "abs" to the names of the practical units to form names for the corresponding C.G.S. units in the electromagnetic and electrostatic systems, so that "abvolt" would be the name for the C.G.S. unit of difference of potential in the electromagnetic system, and absampere for the C.G.S. unit of current in the electrostatic system, led to no discussion, the I.E.E. delegates simply expressing their disapproval of this proposal, which made the same prefix have different numerical values according to the name it preceded.

The chamber of Government delegates, to which Great Britain appointed at the last moment Colonel Crompton,

Dr. Glazebrook, and Prof. Perry as delegates, also considered the questions of units and standards, and at the concluding meeting of the congress the announcement was made that the chamber of Government delegates had decided to advise their respective Governments to appoint a permanent international commission, consisting of two members from each Government, to secure uniformity in units and nomenclature, and a second committee to deal with the international standardisation of machines, this latter to act by correspondence.

The most interesting paper on radio-activity was that of Prof. Rutherford, who traced one step further his remarkable disintegration theory of radio-activity. Starting with the radium emanation, he traced its disintegration through three stages, which he called radium A, B, and C, the latter producing by its disintegration α, β, and γ rays. These changes take place fairly rapidly, and the activity dies away approximately following a logarithmic law. There remains behind, however, in the tube which contained the emanation a deposit the activity of which dies away very much more slowly. By dissolving this deposit in sulphuric acid, it can be separated into two parts, the one of which will deposit on a bismuth disc immersed in the liquid, and the second part will remain behind. That which remains behind is found to give out β rays only, and is called by Rutherford radium D, while that which is deposited on the bismuth disc gives α rays only, and he calls it radium E. He also finds that there is another way of separating these two substances, namely, by heating the deposit on platinum to 1000° C., at which temperature the radium E is volatile and driven off. Regarding the rate of decay of the activity of these two substances, Rutherford estimates that the activity of radium D will fall to half value in about forty years, while that of radium E will require only about one year. By a comparison of the properties of radium E with polonium, Rutherford deduced strong arguments in favour of their identity, and he also considered that radio-tellurium was the same. The product radium D is more uncertain, though it may be radio-lead. If these results are confirmed, and it is proved that polonium, radio-tellurium, and radio-lead are all products of the disintegration of the radium atom, a considerable simplification will result, and a step forward in our knowledge of radio-activity has been made.

The papers by Elster and Geitel concerning natural radio-activity of the atmosphere and the earth, and by Prof. McLennan on the radio-activity of mineral oils and natural gases, gave the results of large numbers of tests on the radio-activity of various waters, oils, muds, &c., from different parts of the earth's surface and from different depths, and they go far to show the omnipresence of radio-activity in the crust of the earth, though they are not yet sufficiently advanced to settle the important question as to whether there exists a large number of radio-active minerals in the earth which have not yet been isolated. McLennan deduces from the rate of decay of the emanation the conclusion that the active substances in natural gases, petroleum, spring-water, and mercury are very probably identical with the emanation from radium, and he also mentions that there appears to be present in some samples of crude petroleum an active substance more persistent than the emanation from radium. Is this the radium D and E of Rutherford?

It was unfortunate that, whereas three important papers on the arc were taken together in one section, the same time was selected for Prof. Child to read his arc paper in a different section, so that those interested in arc phenomena could not hear all the papers; added to this, three out of the four arc papers were not in print at the time of the congress, and the acoustical properties of the rooms in which the meetings were held were of the very worst, making it almost impossible to hear the speakers. Prof. Child attempted to explain the phenomena of the arc on a purely ionic basis, which he summarised as follows:—"The current is carried by ions. These ions are produced, first, either within the kathode, because of its high temperature, or at the boundary surface by the impact of the positive ions; second, through the gas by the impact of the atoms on the negative ions at high temperature; and third, at the boundary surface of the anode by the impact of the negative ions." The theory is, however, not very satisfying, as it throws but little light on many important points, more especially the actions going on at the surfaces of contact of the vapour column and electrodes, as he admits. He also does not attempt to explain the extraordinary effect of slight traces of impurities, which is so marked in the case of the carbon arc that the present writer is of the opinion that with perfectly pure carbon electrodes the carbon arc, as we know it, could not exist.

One of the most interesting facts brought out in Prof. Child's paper is the great importance of the temperature of the *kathode*, and, as he says, "the essential condition appears to be that the kathode shall be very hot." Prof. Steinmetz entered very fully into the importance of the kathode, and he described the stream of particles which he considered as issuing from it. The existence of this stream, and Steinmetz's view that the re-lighting of the alternating arc is a disruptive phenomenon, received striking confirmation from Prof. Lombadi's stroboscopic photographs of the arc.

Prof. Steinmetz deduced an equation for the relation between the arc-length, P.D., and current from theoretical reasoning, which took the form $V=a+b(l+c)/\sqrt{A}$, where V is the P.D., A the current, and l the arc-length; he applied this equation to the volt-ampere characteristics of the magnetite arc, but the agreement between the observed and calculated values seemed as if it would have been better if Mrs. Ayrton's form of equation had been adopted. The magnetite arc looks as if it has a large future before it, as its efficiency is high and the rate of consumption of the electrodes extremely slow. In this connection Prof. Steinmetz said that he had obtained an efficiency of 0.15 watt per mean spherical C.P. with a titanium arc, but that it was not in a commercial form yet. Mr. Blondel, in his paper on impregnated arc light carbons and lamps, gave (if the figures were not misquoted in the reading) an equally extraordinary result with his new lamp and carbons, namely, a mean *hemi*spherical C.P. of 4800 for a 500 watt 9 ampere lamp, as against 700 C.P. for an ordinary open arc taking practically the same power.

Dr. Fleming and Dr. de Forest each contributed papers on wireless telegraphy, and Dr. Guthe gave one on coherer action; there was also a highly mathematical paper on the theory by Mr. Stone Stone. Dr. Fleming's paper gave a good general *résumé* of the subject, but contained very little new matter. The chief interest in de Forest's paper centred in the experiments he describes to prove that the action of his electrolytic receiver is due to polarisation, and not to a heating of the electrolyte as alleged by Fessenden. The electrolytic receiver consists essentially of a very small electrode dipping into an electrolyte, the second electrode being large and connected in series with a cell and telephone. Normally, a very small current flows through the receiver, which is greatly increased directly the oscillations pass through it. Dr. de Forest maintains that this is caused by the oscillations destroying the polarisation at the small electrode, and one of the most conclusive statements he makes in favour of this view is that the small electrode must be made the *anode*, and that the receiver is practically inoperative if it is connected to the negative of the local battery. This would certainly not be the case if the action depended on the heating of the electrolyte, which should be independent of the direction of the local battery.

Dr. Guthe treated at length the theory of the action of the coherer, especially from the electronic point of view. The first step is assumed to be an electrostatic attraction between the metallic particles. The electrons are carried over from the negatively charged metal to the other side, and we have a current carried entirely by the electrons. An increase in the electrical energy produces an increase in the number of electrons, *i.e.* the current increases while the difference of potential remains constant. This passage of electricity is accompanied by a pressure at right angles to the flow, which pushes aside the molecules of the dielectric which may have been between the metallic particles, and there remains what may be considered as a continuous metallic conductor. Dr. Guthe further extends this theory by considering the ionisation of the gas or dielectric surrounding the metallic particles. Both Dr. Guthe's and Dr. Fleming's papers contain numerous bibliographic refer-

ences. Dr. Fleming also proposes the name "kumascopes" for all forms of Hertz wave detectors, but it is not a very pleasant sounding term.

Telegraphy over wires was not neglected by the congress, and Dr. Kennelly gave both an excellent theoretical paper on the transmission speed over submarine telegraph cables, and a practical one on high frequency telephonic circuit tests. To test the telephone circuit for effectiveness a known sinusoidal E.M.F. is applied, and the corresponding received current strength is measured; the ratio of these quantities Dr. Kennelly calls the "receiving end impedance" of the circuit at the frequency used (600 ~ in the tests). If this impedance exceeds a certain value, then the circuit will be defective or inoperative. The interesting part of the apparatus is that used for the measurement of the received current; this is accomplished by passing it through a small platinum wire (Fessenden barretter), which it heats, and the change in its resistance is measured.

By this means, using a 3 micron wire, 23 microamperes can be measured, and with a 1·7 micron wire *in vacuo* 3 or 4 microamperes is said to be measurable. For practical tests on telephone switchboards the use of a sensitive reflecting galvanometer, which the above arrangement involves, is not very convenient, so the change in resistance of the platinum wire is observed by putting it in series with a sensitive milliameter and cell. A complete portable apparatus of this kind was described, with which one scale-division change in deflection of the Weston milliameter corresponded to 1·4 milliamperes of superposed alternating current. Curves are given in the paper showing tests of different lengths of cables.

The improvement of telephonic communication by increasing the self-induction of the circuits is receiving considerable attention in the States, and Dr. Hammond Hayes gave some most striking curves illustrating the reduction in attenuation which has been produced by the use of uniformly spaced loading coils on long circuits. The improvement is very much more marked in the case of cables than air wires. The most striking results are those obtained with a standard telephone cable which was heavily loaded so that the added inductance amounted to about 0·6 henry per mile. In this case, from Dr. Hayes's curves the received current was reduced to about ½ per cent. of the transmitted value at a distance of fifty miles with the cable unloaded, whereas with the loaded cable the received current was 7 per cent. Further, the great importance of terminal reflection where the loaded cable joins the transmitting and receiving apparatus is most marked, as by reducing the self-induction of the end loading coils so as to taper it off and avoid a sudden change in the self-induction the received current was increased to about 18 per cent.

It is also very interesting to note how the curves cross one another, so that short lengths of cable give better results without loading, whereas the cable with loading and terminal taper above six miles long produces less attenuation than the unloaded cable, the advantage in favour of the loaded cable increasing with its length.

There were many other papers of great scientific interest; among these may be mentioned Dr. Pender's paper on the magnetic effect of moving charges, which clears up many of the differences which existed between his results and those obtained by Crémieu, and suggests several other interesting problems; Prof. Wilson on condensation nuclei; two papers on the theory of conduction by Prof. Drude and Prof. Richards; and Prof. Arrhenius's paper on the electric charge of the sun.

In conclusion, it must be said that the congress was a complete success, perhaps more so than might have been expected, considering the great distance many of the members had to travel to attend its meetings, and this was greatly due to the indefatigable energy of its organisers, and especially to Prof. Elihu Thomson, the president, Dr. Kennelly, and Mr. Weaver. The attendance at the meetings was good, and if the discussions were not always as full as could be wished, this was not from lack of interest in the papers, but from lack of time. All the foreign members of the congress, irrespective of nationality, were received and entertained in the most hearty manner by their American *confrères*, fully bearing out the world-wide reputation that America has for hospitality.

W. DUDDELL.

PHYSIOLOGICAL CHEMISTRY IN THE UNIVERSITY OF GLASGOW.

TOWARDS the close of his introductory lecture to the course of physiology in the University of Glasgow on October 13, Prof. McKendrick said:—

I think there can be little doubt that the next great advance in physiology will be from the side of physiological chemistry. The phenomena of vital activity depend on chemical processes in which there are either the building up of complex substances by the union of simpler ones, or the decomposition of complex bodies into simpler ones—in other words, processes that are of a synthetical or of an analytical nature. These chemical phenomena lead, on the one hand, either to the locking up, or, on the other, to the liberation of energy, and the energy in a living being may appear as mechanical motion, heat, electricity, and to some small extent, and in special cases, as light and sound. During the last sixty years many of the physical phenomena of the living being have been investigated by special methods. It seems to me that we cannot expect much more from the application of the graphic method of registration, nor from the examination of the phenomena of electrical action in living tissues. The microscope and the methods of histological research have left little to be desired as to our knowledge of the structure of the elementary tissues and the structure of organs. A new departure must be made. No method of research seems so inviting or so promising as the rigid and methodical investigation of the chemical phenomena happening in living matter.

Hence the extreme importance of the chemist and the physiologist working hand in hand for the future advancement of physiological knowledge. At one time it was supposed that the chemical phenomena happening in the living body were of a different order from those occurring in dead matter. In 1824, however, Wöhler pointed to the first example of a synthetical process discovered within the animal organism. He showed that when benzoic acid is introduced into the stomach it appears as hippuric acid in one of the excretions, after coupling, probably in the liver, with amido-acetic acid or glycocoll. About the same time Hennell effected the synthesis of alcohol, and Wöhler formed urea from ammonium cyanate. As urea was then known only as a product of the animal organism, its synthesis from inorganic substances, and in the laboratory, was a feat of the first importance. This synthesis was the precursor of many others, so that we have now, at the lowest estimate, between two and three hundred chemical substances found in plant and animal tissues that can also be built up synthetically by the organic chemist. Year by year we are adding to this extensive list. Some of these syntheses are striking examples of the knowledge and skill of the chemists of the present day. Such, to mention one brilliant series, are the artificial productions of the sugars by the labours of Fischer and his pupils. Take, again, the formation of the highly complex body camphor, realised by Komppa and Vorländer. It may not be a day-dream if we contemplate the time when even the starches, fats, and proteids we use in our food may also be artificially formed. Physiological chemists have also done much in the way of studying the chemical changes happening to a substance during its passage through the body, but this is a much more difficult branch of physiological chemistry than even the synthetic production of organic bodies.

And yet we are far from solving the mystery of what we may call vital chemistry. When we think, for example, of the synthetical processes by which the chemist constructs complex bodies hitherto only found in the tissues of plants and animals, the question naturally occurs: how does nature produce these complicated molecules without the use of strong reagents and high temperatures? This aspect of the question has been well discussed by my friend Prof. R. Meldola, first, in an address as president of the chemical section of the British Association at the Ipswich meeting in 1885, and, second, in an important work, soon to be published, the proof sheets of which he has kindly allowed me to peruse, entitled "The Chemical Synthesis of Vital Products." It is clear from a study of the examples given by Prof. Meldola that the synthetical processes worked out by the chemist in his laboratory are quite unlike those occurring in plant and animal tissues, and yet the result is the

same, namely, the production of a complex organic compound. We have been too much in the habit of supposing that when we could represent the process followed by the chemist by an equation, that this equation represented what occurred in the plant or animal tissue. Physiologists more than chemists have erred in this direction, and many of the statements in our text-books are either superficial or grossly misleading. The chemist attains his end by violent means and with considerable rapidity, whereas, in the silent laboratory of the plant and animal cell, molecular processes are slowly carried on of which we know at present next to nothing. It is strange, for example, that we cannot yet follow all the steps of the process by which, under the action of sun-light, the green colouring matter in a vegetable cell can fix the carbon of the carbonic acid of the air and liberate the oxygen. Nor can we follow satisfactorily the steps of the synthesis by which the carbon is built up into such a substance as starch or sugar. Yet this is a synthesis accomplished every day by every green plant. Such phenomena in all probability are accomplished through the agency of enzymes or ferments, but their real nature is still obscure.

I have said enough to show you the vast importance of chemical investigation in the physiology of the future. Chemistry is but a highly specialised branch of physics. In these days all the new discoveries in physical chemistry, such as the true nature of solution, the facts of dissociation as exemplified by such a common phenomenon as the splitting up of common salt into the ions chlorine and sodium, the charging of each ion during electrolysis, and the laws of osmotic pressure, which no doubt regulate nutrition and the interchanges of blood and lymph, must be taken into account by the physiologist. Such research demands adequate laboratory accommodation and highly trained specialists. I am glad to say our university will soon be in a position to take her share in this new development of physiological science. The splendid laboratories now being built for physiology, public health, and materia medica will be a home for work of this kind, and the endowment of a lectureship in physiological chemistry by the trustees of the late Dr. John Grieve (who left 8000*l.* for the foundation of a lectureship in connection with the medical faculty of the university) will enable us to obtain the services of a trained specialist, who will give his undivided attention to this department of physiology. No subject more than physiology illustrates the truth that all science is one. Physics, chemistry, physiology, and all the others are only different ways of investigating the phenomena of nature. The phenomena of life are, however, the most difficult of all to investigate, and it may safely be asserted that the highest skill in experimental research and the deepest knowledge of chemistry and physics are required for such work. Throughout the scientific world physicochemical researches are now in progress into physiological and bacteriological processes, lectureships and laboratories are springing up here and there, and it is gratifying to be assured that the University of Glasgow will be able to take her share in this work.

CONDENSATION NUCLEI.[1]

A FAMILIAR experiment was first shown illustrating the action of ordinary dust particles as condensation nuclei. From a large globe, which had been allowed to stand for some hours, some of the air was removed by opening communication with an exhausted vessel. Only a very few drops were formed as a result of the expansion. On allowing air to enter the globe through a cotton-wool filter, so that the pressure was brought back to its original value (that of the atmosphere), and allowing the air to expand as before, the drops formed were again very few. The ordinary air of the room was now admitted; an expansion of the air in this case resulted in the production of a thick fog.

When air has been freed from dust by filtering, or by repeatedly forming a cloud by expansion, and allowing it to settle, the vapour which, in the presence of the nuclei, would have separated out in drops, must be in the "supersaturated" condition immediately after the expansion is completed.

[1] Discourse delivered at the Royal Institution on Friday, February 19, by C. T. R. Wilson, F.R.S.

Another method of producing clouds was now shown. Air was allowed to escape through a fine orifice into an atmosphere of steam; the mixed air and steam were then passed through a Liebig's condenser, where the greater part of the steam was condensed, and then into a large glass globe, where the clouds were observed. From this vessel the air was drawn off by a pump which maintained the pressure in the globe and condenser at a considerable number of cms. of mercury below that of the atmosphere. Before reaching the jet the air of the room had to pass through a cotton-wool filter, and then through a long tube containing water; finally it was led through an aluminium tube to the orifice. The latter was about half a mm. wide. The fall of pressure in passing through the orifice was about 15 or 20 cm. In the absence of the filter, the air being admitted directly to the water tube through a tap turned just sufficiently to give the same flow as with the filter, a dense fog poured out from the end of the condenser tube; on closing the tap and letting the air enter through the filter the fog rapidly cleared, and only a fine rain continued to be produced. While the apparatus was in this condition an X-ray tube was set in action near the aluminium tube; the rain was succeeded by fog, which continued to pour out from the end of the condenser so long as the X-rays were kept in action. Condensation nuclei are, as this experiment proves, produced in air exposed to Röntgen rays. Later experiments will, however, show that they have entirely different properties from the ordinary dust nuclei.

When air has been completely freed from dust particles, so that a slight expansion of the air (initially saturated with water vapour) does not result in the formation of any drops, it is found that quite a high degree of supersaturation may be brought about without the appearance of a single drop. There is, however, a limit to the supersaturation which can exist without condensation of the vapour in drops resulting. To study this condensation in dust-free air, and to measure the expansion required to produce the necessary degree of supersaturation, a special form of expansion apparatus is required. The lantern slide thrown on the screen shows the construction and mode of working of the apparatus. The second slide is a photograph of the machine in action, the exposure having been made immediately after an expansion; the cloud formed (in this case on nuclei produced by the action of radium) is plainly visible along the path of a concentrated beam of light from a lantern.

Let us now try an actual experiment with the expansion apparatus. On making a slight expansion a cloud forms on the dust particles which are present; this slowly settles to the bottom of the vessel. The air is allowed to contract to its original volume, and a second expansion of the same amount is made. The drops formed are on this occasion comparatively few, and they fall rapidly; the dust particles have nearly all been carried down with the drops formed by the previous expansion. The fewer the nuclei on which water condenses the larger will be the share of water available for each drop, and the more rapid will be the fall. The next expansion produces no drops. While the air is in the expanded condition, the piston being at the bottom of the expansion cylinder, air is removed from the cloud chamber by opening the connection to the air-pump until the pressure is about 13 or 14 cm. of mercury below that of the atmosphere; the piston is again allowed to rise by putting the air space below it in communication with the atmosphere. The next expansion is thus comparatively large, the pressure after the expansion has taken place and the temperature has risen to its original value being 13 cm. or more below the initial pressure. Yet, in spite of the high degree of supersaturation reached, not a drop of water is seen. Making the fall of pressure 16 cm., however, we see on expansion a shower of drops; and although these drops are few and large, falling therefore rapidly, yet, however often the same expansion be repeated, the drops produced on expansion show no diminution in number. Thus the nuclei removed with the drops are continually replaced by others manufactured within the apparatus itself.

To produce the necessary supersaturation to cause condensation in the form of drops in dust-free air, the air must be allowed to expand suddenly until the final volume is 1·25 times the initial volume. The condensation is rain-like in form, and, moreover, the number of drops remains small although the expansion considerably exceeds this lower limit.

Expansions exceeding the limit, $v_2/v_1 = 1\cdot38$, however, give fogs, which increase rapidly in density, *i.e.* in the number of the drops, as the expansion is increased beyond this second limit. The expansions required for the rain-like and cloud-like condensations correspond to a fourfold and eightfold supersaturation respectively.

A further experiment will throw light on the nature of the nuclei associated with the rain-like condensation. Let us expose the moist air to the action of X-rays before causing it to expand. First let us try an expansion very slightly less than that required to give the rain-like condensation without the rays. You observe no drops are formed. Now let the expansion be slightly greater than the critical value 1·25. A fog is seen on expansion. Thus the X-rays produce in the air immense numbers of nuclei having the same properties, so far as their power of assisting condensation goes, as the comparatively few nuclei which the rain-like condensation makes visible. Now a gas exposed to X-rays conducts electricity, and the otherwise complicated phenomena of this conduction are all reduced to comparative simplicity by the theory that under the action of the rays equal numbers of freely moving positively and negatively electrified bodies (the ions) are produced from the originally neutral gas. It is at once suggested that the condensation nuclei produced by X-rays are simply these ions.

Let us now impart conducting power to the gas by exposing it to the action of the radiation from radium. Again we have the same result; no drops are produced if the expansion be less than 1·25, fog if the expansion exceeds this limit.

If we substitute for the glass shade, which has thus far formed the cloud-chamber, a glass cylinder with a horizontal metal top, we have the means of testing whether the condensation nuclei produced by Röntgen or radium rays are really electrically charged, whether, in fact, it is the ions themselves which act as condensation nuclei or other particles produced by the rays. If, for example, the roof of the cloud chamber be kept positively charged, the floor negatively, the negatively charged ions will travel upwards and the positively charged ones downwards. In the absence of an electric field the positive and negative ions produced by the action of the rays will go on increasing in number until as many are neutralised by recombination with ions of the opposite kind, or by coming in contact with the walls of the vessel, in each second as are set free in that time by the rays. If the rays be cut off, the removal of ions by recombination and diffusion will continue, and the number of ions in the vessel will diminish rapidly.

Experiment shows that, while in the absence of an electric field, quite a considerable fog is formed when an expansion, slightly exceeding 1·25, is effected ten seconds after the rays have been cut off, with 200 volts between the upper and lower plates the same expansion, allowed to take place three or four seconds after the stopping of the rays, produces only a very slight shower. Or, again, if the rays be kept on all the time the resulting fog is very much less dense with the electric field acting than without it. These results are easily explained if we assume that the condensation nuclei are the ions, and apply the result obtained by purely electrical methods, that the ions travel about 1·6 cm. per second in a field of 1 volt per cm. The nuclei causing the rain-like condensation without exposure to Röntgen or radium rays are also removed by the action of an electric field; we have thus the direct proof that they also are ions. Recent experiments have proved that a charged conductor suspended within a closed space loses its charge by leakage through the air, and that the conduction shows all the peculiarities of that met with in an ionised gas; and, indeed, it appears that this ionisation is due to the action of radiation of the radium type from the walls of the vessel and from outside the vessel. The condensation method of detecting ions is, it may be pointed out, a very delicate one; a single ion if present in the vessel will be detected.

The positive and negative ions are not alike in their power of acting as condensation nuclei. In most of the experiments shown to-night the negative ions alone have in fact come into action. The positive require a considerably greater expansion in order that water may condense upon them. The final volume must for the positive ions be about 1·31 times the initial instead of only 1·25, corresponding to a sixfold instead of a fourfold supersaturation.

To demonstrate the difference between the positive and negative ions the same form of apparatus is used as in the previous experiment. Instead, however, of a difference of potential of 200 volts, only 2 or 3 volts are applied between the plates; and in this experiment only a thin layer close to the lower plate is exposed to the action of the rays. Under these conditions, if the upper plate is the positive one, the negative ions will be attracted upwards out of the ionised layer, and will occupy the greater part of the volume of the vessel, while the positive ones will have only a short distance to travel before reaching the lower plate. If the rays be cut off before the expansion is made it is easy to arrange the interval to be of such a duration that all the positive ions have been removed, while only a small fraction of the negative ions have reached the upper plate before the expansion takes place. Thus we can try the effect of expansion when the vessel is charged with practically negative ions only. By reversing the electrical field the action of positive ions, almost free from negative ions, can be studied. When the expansion is between 1·25 and 1·31 a fog or a mere shower is obtained, according as the direction of the field is such as to drive negative or positive ions upward.

The ions are by no means the only nuclei which can be produced within moist air from which the dust particles have been removed. Among the most interesting of such apparently uncharged nuclei are those produced in moist air exposed to ultra-violet light. It is impossible in the time available to do more than allude to them here.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The reader in animal morphology (Mr. Sedgwick) gives notice that a special course of advanced lectures on certain general aspects of zoology will be given at the zoological laboratory during the Michaelmas and Lent terms, beginning Friday, October 28. The course will include lectures by the following, and will be given as nearly as possible in the order indicated:—Michaelmas term: Mr. Doncaster, the nucleus and heredity; Mr. Lister, Foraminifera and Mycetozoa; Mr. Punnett, metamerism. Lent term: Mr. Gardiner, the œcology of aquatic animals; Mr. Brindley, certain aspects of regeneration; Mr. Hopkins, animal pigments; Mr. Fletcher, cell-structure, cell-division, and maturation of germ-cells; Mr. Heape, some problems connected with the comparative physiology of the generative system.

Dr. Donald MacAlister, St. John's, who has represented the university on the General Medical Council since 1889, and is now chairman of the British Pharmacopœia Committee, was re-elected for a fourth period of five years on October 24.

A university lectureship in applied mathematics is vacant by the appointment of Mr. H. M. Macdonald to be professor of mathematics in the University of Aberdeen. The readership in botany is vacant by the resignation of Mr. Francis Darwin. These offices will be filled up during the present term.

The Gedge prize in physiology has been awarded to Mr. K. Lucas, fellow of Trinity, for his paper on "The Augmentor and Depressor Effect of Tensions on the Activity of Skeletal Muscle."

The number of students of the first year matriculated on October 21 was 884, or for the whole year up to that date 923.

The late Mr. Henry Evans, of Trinity College, bequeathed to the university his collection of British Lepidoptera.

The following examiners have been appointed for the natural sciences tripos:—Physics, R. T. Glazebrook and W. C. D. Whetham; chemistry, H. O. Jones and Prof. A. Smithells; mineralogy, Prof. W. J. Lewis and L. J. Spencer; geology, A. Harker and Dr. F. A. Bather; botany, A. C. Seward and H. Wager; zoology, A. Sedgwick and Prof. W. A. Herdman; physiology, W. M. Fletcher and Prof. E. Waymouth Reid; anatomy, Dr. E. Barclay Smith and Prof. A. Robinson.

LORD KELVIN will be installed as Chancellor of the University of Glasgow in the Bute Hall on Tuesday, November 29.

PROF. WINDLE, Dean of the Medical Faculty at Birmingham University, has been appointed to the presidency of Queen's College, Cork, in succession to Sir Rowland Blennerhassett.

PROF. HARRY E. CLIFFORD has been appointed acting head of the department of electrical engineering at the Massachusetts Institute of Technology, Boston, in succession to Dr. Louis Duncan, resigned.

AT a meeting of the governors of the South-Eastern Agricultural College at Wye, held on Monday, October 24, it was decided to develop further the forestry department, for which a grant will be sought from the Board of Agriculture.

MR. SIDNEY H. WELLS and the Rev. James Went have accepted the invitation of the President of the Board of Education to serve on the consultative committee in place of Prof. Henry E. Armstrong and the Rev. Dr. Gow, who retire in accordance with the terms of the Order in Council by which the committee was constituted.

YALE University, it is reported, will receive by the will of Mr. Levi Clinton Weits the sum of about 40,000*l*. We learn further from *Science* that the veterinary department of the University of Pennsylvania has received an anonymous gift of 20,000*l*., Columbia University a gift of 3250*l*. from Mr. H. E. Garth for the establishment of a scholarship, and 2000*l*. from an anonymous donor for the purchase of books.

A WELSH national conference on the training of teachers is to be held at Shrewsbury on November 10 and 11. Representatives from the Court and Senate of the University of Wales, from the Council and Senate of each of the Welsh university colleges, from the local education authorities, the local governing bodies, as well as from the educational associations throughout Wales, are expected to be present. The conference will be fully representative, and is expected to have important results.

BY the will of the late Dr. Isaac Roberts, the reversion of his residuary estate, probably between 30,000*l*. and 35,000*l*., is to be divided equally between the University of Liverpool and the University Colleges of North and South Wales, for the purpose of founding scholarships. In the award of the scholarships preference is to be given to persons studying or intending to study astronomy, biology, zoology, botany, chemistry, electricity, geology, and physics, under conditions determined by the councils.

NEW physical and engineering laboratories were opened at the York Railway Institute of the North-Eastern Railway Company on October 20 by Sir Edward Grey. During the course of an address, Sir Edward Grey said he was convinced that no country was more qualified by nature and brains to make use of good scientific training than our own, and, therefore, there was all the more reason why there should be good opportunities of acquiring it. In the great struggle for success everything depended on the use made of scientific discoveries.

DR. C. POMERANZ has been appointed assistant professor of chemistry in the University of Vienna, Dr. Johannes Königsberger assistant professor of theoretical physics at Freiburg, and Dr. Paul Rabe, of Jena, has been raised to the standing of assistant professor at Jena. Profs. H. Joly (mathematics) and A. Dommer (mechanics), of Lausanne, have been raised from the rank of assistant to that of ordinary professor. Dr. Sommer has been appointed professor of mathematics at the Danzig Technical College; Dr. Kurlbaum, of the Charlottenburg National Physical Laboratory, has been appointed ordinary professor at the Berlin Technical College; and Dr. Max Bodenstein assistant professor of chemistry at the University of Leipzig.

THE meeting of teachers engaged in London polytechnics, technical institutes, and schools of art, announced in our last issue, was held at Birkbeck College on October 22, to promote an association of technical teachers for the advancement of technical education generally, interchange of ideas on methods of teaching, and the safeguarding of professional interests. The following resolution was adopted by a large majority:—"That this meeting hereby decides to form an association of science, technological, and art teachers engaged in the London polytechnics, technical institutes, and schools of art, such association to comprise both permanent staffs and evening teachers, other than those engaged in purely secondary work." An executive committee of fifteen members was appointed to draft rules and constitution, and to report to a general meeting to be held in January.

A COPY of the prospectus for 1904–5 of the Leith Nautical College has been received. The college is devoted wholly to technical instruction in subjects directly connected with the sea. It is equipped with physical and mechanical laboratories and appliances for every branch of nautical education. Experimental work is provided in magnetism and electricity in regard to their seafaring application, in the teaching of seamanship, and in shipbuilding. The teaching arrangements are framed to suit the needs of the migratory seafaring community; for students can enter at any time, and can attend for long periods or for recurring short periods, as may be convenient to them. The work of the college, as the programme of instruction shows, is in no way limited by the requirements for the Board of Trade examinations, but every facility is offered in the numerous subjects of a higher naval education. Among courses of study included in this programme may be mentioned those on oceanic meteorology and instruments, with the bearing of meteorological elements on ocean routes, and on ship manœuvring in cyclones; on shipping and commercial law, including the commercial duties of a shipmaster; and on ship surgery, medicine, and hygiene at sea. Special classes have been arranged for fishermen in fisherman's navigation, weather knowledge, knotting and splicing, and in rigger's work.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 17.—M. Mascart in the chair.—On the four first numbers of the photographic catalogue of the heavens published by the Observatory of Toulouse: M. **Lœwy.** The parts now published contain the rectilinear coordinates of 32,275 stars, obtained from 186 negatives. The introduction to vol. ii., by M. Baillaud, also gives a complete account of the method of reduction followed at Toulouse, as well as of the special methods used in the measurements of the coordinates and for the calculation of the constants. An account is also given of the method adopted for measuring the relative magnitudes of the stars and of an experimental study of the photographic objective employed. Statistical studies made at the Observatories of Oxford, Toulouse, and Potsdam have shown that the mean distribution of the star images in the negatives of the catalogue is not uniform, and prove that the focal surfaces of the six objectives studied (Algeria, Oxford, Paris, Potsdam, San Fernando, and Toulouse) have an appreciable curvature.—The study of the third group of air bands with a strong dispersion: H. **Deslandres** and A. **Kannapell.** A detailed description is given of the study of the third group of air bands occupying the more refrangible half of the ultra-violet region (λ 3000 to λ 2000). The general result confirms the conclusions arrived at in 1885, each band under strong dispersion being always formed of eight series of rays in arithmetical progression. A drawing is given for the band λ 2370, in which this structure is clearly shown.—On a new system of micrometers: G. **Millochau.** The wire micrometer, which is attended with certain inconveniences, is replaced by an instrument based on the principle of the heliometer. Two identical plates of glass with parallel faces are placed in a plane perpendicular to the optical axis of the telescope employed, between the objective and the eye-piece. The plates turn round a common axis and give rise to a double image of the star, the distance between the two images being practically independent of small displacements of the telescope.—Observations of the sun made at the Observatory of Lyons with the 16 cm. Brunner equatorial during the second quarter of 1904: J. **Guillaume.** The results are summarised in three tables giving the number of spots, their distribution

in latitude, and the distribution of the faculæ in latitude.—The elements of molecular vibrations in relation with the sense of propagation of sound waves: L. **Bard.** In view of the impossibility of explaining the orientation of sound by the ear by the usual theories, the author propounds two hypotheses to explain this.—Researches on the boiling points of mixtures of volatile liquids: C. **Marie.** The boiling point constants of a given pair of volatile liquids and a non-volatile substance being given, the question is raised as to whether it is possible to calculate, *a priori*, the value of the boiling point constant corresponding to the mixture. This calculation has been made by Nernst, and an experimental study of this formula has been made by the author with mixtures of water and alcohol and resorcinol. The divergence between the theory and the results of the experiments is considerable, and an examination of the fundamental assumptions used in the formula is made to see if the cause of the divergence can be elucidated. Further experiments are required before the theory can be completely made out.—The action of solutions of organomagnesium compounds on the halogen derivatives of phosphorus, arsenic, and antimony: V. **Auger** and M. **Billy.** Phosphorus trichloride reacts violently with solutions of magnesium methyl iodide, giving the chloride of tetramethylphosphonium, phosphorus iodide, and magnesium chloride. With chloride of arsenic the chief product of the reaction is trimethylarsine oxide; with antimony trichloride several substances are formed, from which, by treatment with potassium iodide, the iodide of ethylstibine can be isolated.—On an organic persulphate: R. **Fosse** and P. **Bertrand.** The sulphate of dinaphthopyranol, obtained by treating dinaphthopyranol with dilute sulphuric acid, possesses oxidising properties, setting free iodine from an acidified solution of potassium iodide, and oxidising alcohol to aldehyde. It thus appears to be a true persulphate, analogous in composition with Caro's acid.—The constitution of rosaniline salts and the mechanism of their formation: Jules **Schmidlin.**—Anthracène tetrahydride and octahydride: Marcel **Godchot.** These hydrides have been obtained by applying the method of Sabatier and Senderens. The octahydride is the more stable of the two, and is the main product when the hydrogenation is carried out at 200° C. The oxidation products and the reactions with the halogens have been studied.—On the origin of the carbonic acid of the seed during germination: Edouard **Urbain.** It is established that the carbon dioxide is produced at the expense of the albuminoid materials of the seed.—Study on the successive states of plant material: Eug. **Charabot** and Alex. **Hébert.**—Vital periodicity of animals submitted to the oscillations of level in deep sea: Georges **Bohn.**—The agglutinating cells in the Eolidia: Paul **Abric.** Description of some new species of trypanosomes and parasitic Hæmogregarina of marine Teleostea: E. **Brumpt** and C. **Lebailly.**—On the auxospores of two pelagic diatoms: J. **Pavillard.**—The geology of the Ortler region: Pierre **Termier.**—On macles: G. **Friedel.**

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 28.

PHYSICAL SOCIETY, at 5.—An Interference Apparatus for the Calibration of Extensometers: John Morrow and E. L. Watkin.—A Sensitive Hygrometer: Dr. W. M. Thornton.—Note on a Property of Lenses: Dr. G. E. Allan.

SATURDAY, OCTOBER 29.

ESSEX FIELD CLUB, at 6.30 (at Essex Museum of Natural History, Stratford).—Fresh-Water Biological Research and Biological Stations: D. J. Scourfield.

TUESDAY, NOVEMBER 1.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Inaugural Address by the president, Sir Guilford L. Molesworth, K.C.I.E.—Presentation of the Council's Awards, and Reception in the Library.

WEDNESDAY, NOVEMBER 2.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Detection and Estimation of Small Quantities of Maltose in the Presence of Dextrose: Julian L. Baker and W. D. Dick.—The Use of Palladium-Hydrogen as a Reducing Agent in Quantitative Analysis: Alfred C. Chapman.—Some Recent Abnormal Milk Results: Sidney Harvey.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 3.

CHEMICAL SOCIETY, at 8.—Note on the Action of Nitric Acid on the Ethers: J. B. Cohen and J. Gatecliff.—The Condensation of Formaldehyde with Acetone (Preliminary Note): E. A. Werner.—Union of Hydrogen and Chlorine. Rate of Decay of Activity of Chlorine: J. W. Mellor.—The Action of Phthalic Anhydride on α-Naphthylmagnesium-bromide: S. S. Pickles and C. Weizmann.—The Constitution of Nitrogen Iodide: O. Silberrad.—The Available Plant Food in Soils: H. Ingle.—The Combustion of Ethylene: W. A. Bone and R. V. Wheeler.—The Decomposition of Methylurea: C. E. Fawsitt.—The Influence of Certain Salts and Organic Bodies on the Oxidation of Guaiacum: Miss E. G. Willcock.—The Influence of Potassium Persulphate on the Estimation of Hydrogen Peroxide: J. A. N. Friend.—The Dynamic Isomerism of α- and β-Crotonic Acids (Preliminary Note): R. S. Morrell and E. K. Hanson.—The Influence of Sunlight on the Dissolving of Gold in an Aqueous Solution of Potassium Cyanide: W. A. Caldecott: (1) The Fractional Hydrolysis of Amygdalinic Acid; (2) Isoamygdaline: H. D. Dakin.

RÖNTGEN SOCIETY, at 8.15.—The Presidential Address: C. Thurston Holland.

FRIDAY, NOVEMBER 4.

GEOLOGISTS' ASSOCIATION, at 8.—Conversazione.

MONDAY, NOVEMBER 7.

ROYAL GEOGRAPHICAL SOCIETY (Albert Hall), at 8.30—The Work of the National Antarctic Expedition: Captain R. F. Scott, R.N.

TUESDAY, NOVEMBER 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Coast Erosion: A. E. Carey.—Sea-Coast Erosion on the Holderness Coast of Yorkshire: E. R. Matthews.

FRIDAY, NOVEMBER 11.

ROYAL ASTRONOMICAL SOCIETY, at 5.

CONTENTS.

SUPPLEMENT TO "NATURE."

LORD KELVIN ON OPTICAL AND MOLECULAR DYNAMICS.

Baltimore Lectures on Molecular Dynamics and the Wave Theory of Light. By Lord Kelvin, O.M., G.C.V.O., P.C., F.R.S. Pp. xxii+694. (Cambridge: University Press, 1904.) Price 15*s.* net.

IN the autumn of the year 1884 Lord Kelvin delivered at Johns Hopkins University a course of lectures "On Molecular Dynamics and the Wave Theory of Light," mainly *extempore,* which, having very fortunately been reported stenographically by Mr. A. S. Hathaway—one of his band of auditors, the famous "twenty-one coefficients"—were issued to the world unrevised in a papyrograph volume at the end of the same year, and have since been known as the "Baltimore Lectures." The report, being nearly *verbatim,* showed how comparatively slight were the immediate preparations that Lord Kelvin had made for some portions of his task, and thus had the great advantage of revealing the procedure and attitude of an investigator of transcendent genius in face of regions of his subject more or less new to him.

One result, in fact, of his enthusiasm for the new aspect of optical propagation revealed by the phenomena of anomalous dispersion, and of the wealth of mechanical illustration which, taking his audience into collaboration, he provided for this hitherto rather abstract subject, was to start a period of enlivened interest, illustrated by memoirs by Lindemann and others, abroad and in this country; this has now reaped a reward in fruitful comparison of the theory with experimental data obtained over the enormous range of six or seven octaves by Langley, Rubens, and other pioneers. Irrespective of this phenomenon of anomalous dispersion in the spectrum near a region of absorption of the light, Lord Kelvin's own estimates of molecular dimensions had already ruled out the earlier attempts of Cauchy and his followers to base dispersion on mere loading of the æther by massive molecules. On such a theory of inert molecular masses the proportional dispersion per octave could depend only on the ratio of the intermolecular distance to the wave-length, no other magnitudes coming into consideration, and it must depend on the square of this ratio; thus the actual 1 per cent. dispersion for glass would be explicable by about 10 molecules per wave-length, while with the real number, about 10^4, the circumstances would be practically the same as for a uniformly distributed load, which would give no dispersion at all. The modern theory of dispersion thus must rest on an investigation of the interaction between the forced internal vibration of the molecules, conditioned by their own proper periods, and the periodic impressed vibration of the wave-motion which produces it. So long as the internal dynamics of the molecule remain unexplored, only general principles can be applied, and it matters little to the argument whether it is conducted in terms of a mechanical conception of radiation or in terms of the electric theory; in either case only the general frame into which the facts are to be fitted can be supplied by theory. On a mechanical view, mere loading may produce refraction but not dispersion; so on the electric view, even if there were no free periods in the ordinary sense, there would remain an index of refraction equal to the square root of the dielectric coefficient.

In the preface to the present volume Lord Kelvin states that he chose for his lectures the subject of the wave-theory of light with the object of accentuating its points of failure, thereby intending to stimulate the activities of his audience towards extending further "the floods of new knowledge splendidly enriching the whole domain of physical science" that had flowed from the theory.

"We all felt that difficulties were to be faced and not to be evaded; were to be taken to heart *with the hope of solving them if possible*; but at all events with the certain assurance that there is an explanation of every difficulty, though we may never succeed in finding it. It is in some measure satisfactory to me, and I hope it will be satisfactory to all of my Baltimore coefficients still alive in our world of science, when this volume reaches their hands; to find in it dynamical explanations of every one of the difficulties with which we were concerned from the first to the last of our twenty lectures of 1884."

The sentences quoted contain the key to much (though far from all) of Lord Kelvin's mathematical investigation of the last twenty years. The result is this magnificent volume of more than 700 pages, which in its variety of contents and width of grasp forcibly recalls the original "Thomson and Tait" of forty years ago, except, indeed, that the form of a treatise being now dispensed with, the author is at liberty to go directly for the various subjects of interest that hold his attention without any necessity for preliminary didactic expositions.

The earlier lectures are reproduced here with additions within brackets, but the author soon found that it was easier to re-write the greater part of the material. His expression of distrust of "the so-called electromagnetic theory of light" (p. 45) stands as in the original. Along with it is the interesting statement that he had worked out for himself, as early as the year 1854, the result that an electric impulse is propagated along a cable with a velocity of the order of that of light, and that it only required a knowledge of the ratio of the electric units to lead to the result that for an air dielectric it would agree with the velocity of light in air. An investigation of such linear propagation, on the lines now familiar, and thoroughly developed by Heaviside, is inserted as the last appendix (L). The first published determination of this velocity is contained, as is well known, in Kirchhoff's memoir of 1857; there the result is deduced on the basis of Weber's theory of moving electrons, which act on each other instantaneously at a distance, the law of attraction involving their velocities as well as their distance apart. Neither there nor in the ordinary modern investigation for cables is there any reference to transmission of electric effects across space with finite speed; that makes no difference for the case of enclosed cylindrical dielectrics of diameter small compared with the wave-length, for with them it is only the adjacent parts of the electric distribution and

current on the conducting boundaries that are sensibly effective as regards the internal state of each element, and their mutual influences are adjusted in times which are in any case inappreciable in an estimate of the times required for transmitting effects along the cylinder. For wider cylinders or shorter waves, the Weberian formula of Kirchhoff gives a result differing from the velocity of radiation, of which Maxwell was of course well aware, while Lord Kelvin's approximate treatment is no longer applicable. We now know that, to transform the Weber-Kirchhoff formulæ into those of the modern electron theory, it is only necessary, in the integral expressions for the vector potential of the current and the scalar potential of the charges, to consider each element as propagated through space with the velocity of radiation instead of being transmitted instantaneously.

One of the great historical difficulties in optical theory, above referred to, was that of embracing the phenomena of propagation in crystals and of reflection from transparent bodies within the dynamics of ordinary elastic solid media. This problem was resolutely attacked by Green nearly sixty years ago with a brilliant but unsuccessful result, and no success in adapting his analysis was achieved by anyone else until some three years after the Baltimore lectures were delivered. Then Lord Kelvin produced his theory of an elastic medium with finite rigidity but perfectly labile as regards compression, and characteristically illustrated it by material structures, such as a mass of foam *in vacuo*, which resist distortion but are insensitive to shrinkage of volume. If luminiferous media were elastically like this, the necessity of continuity of displacement normal to a reflecting interface would no longer press upon the theory, for the two media would stretch locally in the direction of the normal without reaction on the other stresses, just as much as might be required. And it was promptly pointed out by Glazebrook that the arrangement which thus allowed Fresnel's laws for reflection was also competent to explain propagation in crystals by the simple expedient of making the inertia æolotropic, while the lability as regards compression is again all that is wanted to obtain the ascertained laws of MacCullagh's theory (Lord Kelvin's rotational æther) or the electric theory for crystalline reflection. In fact, one advantage accruing with the electric theory is that it dissects the accepted and unique formal analysis of propagation of light into a series of linear relations between various vectors, each of which has a distinctive name and quality; and according as we take one or other of these vectors to represent a displacement of an elastic medium, we have the various mechanical theories of Fresnel, MacCullagh, and Sarrau and Boussinesq, differing in the types of interfacial continuity that they require, but algebraically the same; the exact duality between the systems of Fresnel and Sarrau is in this way open to direct inspection. Such, then, was Lord Kelvin's solution of 1887, in which all media were taken to be labile as regards compression, the type which Green had rejected under the idea that it was intrinsically unstable; this classical objection Lord Kelvin at once removed by the illuminating remark that the medium only required to be held fixed at an outer boundary to prevent any internal collapse. There was something unnatural about this, as its author admitted, and it now appears that an æther so constituted would still absorb much condensational energy from vibrators; but here in 1904 comes the further crucial remark that only one of the two media need be thus labile in order to confer the requisite freedom for reflection without interference from compressional waves; the æther itself may remain incompressible, as Green took it to be, but the interaction of æther and molecules in every material body is to be such as always to make it labile or inelastic for compressional disturbance. It need not, however, be absolutely labile if Fresnel's laws are to be satisfied only within experimental limits. And here the remarkable peculiarity of highly refractive substances like diamond, the "adamantine property" discovered by Airy, which replaces an abrupt change of phase in passing the polarising angle by a gradual though rapid one, comes into consideration; if only the velocity of propagation of the condensational wave in material media is a small complex quantity, the complexity will introduce just the gradual change of phase that is required in order to include that property. Moreover, if this velocity is a pure imaginary, there will be no loss of energy involved; this happens for a granular or discrete medium whenever there are periods of free internal vibrations among its constituent granules that are longer than the period of the waves under consideration. If we cannot include the adamantine property as introduced in this way through total reflection for compressional waves, no resource is known except that of gradual transition at the surface; this Lord Rayleigh has shown to be the main cause for water, as careful cleansing of the surface almost entirely removes the phenomenon.

In this chain of simple, yet brilliant and attractive, ideas, Lord Kelvin has gradually forged a reconciliation between fact and theory that would probably have been received with universal acclaim thirty years ago. Nowadays, as regards most people, the need has ceased to be so strongly felt; for better for worse most of us are now wedded to the electric theory of light, the creation of Lord Kelvin's most famous disciple, which forms a consistent scheme of the relations of electricity and radiation, perfectly definite and unambiguous with the large simplicity of nature itself, that has led into no essential contradiction with fact, though it has many times predicted phenomena of the most essential and fundamental kinds.

Not that there is any difference of opinion as to the value of the electric theory. Lord Kelvin would doubtless agree that, as a new mode of grouping of the relations, it has placed them in a most fruitful light, and shown the directions of natural development. He would perhaps say that it is a successful description rather than an explanation, and he would probably desire to modify the terms of the description in order to bring it closer to the train of dynamical ideas in which he would search for the explanation. And here we are at the parting of the ways. Is it incumbent on us to treat the æther as strictly akin

to the material bodies around us? or may we assign to it a constitution of its own, to be tested by its success in comprehending the complex of known relations of physical systems? This is not the occasion to follow up that question. It would appear that Lord Kelvin cannot grant that such a constitution has been determined until it has made clear in full detail the mode of connection of the atom with the æther, so that a precise mechanical model of it could be imagined; whereas, on the other side, it may be held to be the merit of the scheme that it evades such a hopeless task, and defines physics as relating to the surrounding field of æthereal activity of the molecules rather than to the molecules themselves, which must remain in many respects inscrutable—a consummation that would hardly have been attempted had not the illuminating conception of Lord Kelvin's vortex-atoms shown the way.

The plan along which Lord Kelvin now finds it most hopeful to pursue ultimate physical synthesis admits the existence of "electrions," freely mobile through æther simply because two media can be superposed independently in the same space, which exert direct *force at a distance* upon the æther as also does the matter itself, that the forces are so enormous as sensibly to compress or expand the æther around these nuclei, and that the source of electric, chemical and elastic action is thus to be found. This conception is developed over many pages with the power and conciseness that are familiar to his readers; it remains a question for the future whether it will prove to be a fruitful theory; it certainly forcibly illustrates many deep molecular phenomena, and demands, and will doubtless receive, very careful study.

The point of view is illustrated in p. 300, in treating of the spheres of activity of the various kinds of molecules, where Lord Kelvin states that this "is a most interesting subject for molecular speculation, though it or any other truth in nature is to be explained by a proper law of force according to the Boscovichian doctrine which we all now accept (many of us without knowing what we do) as the fundamental hypothesis of physics and chemistry." When one reflects that to Lord Kelvin, more than to anyone else except Faraday, has been due the stimulus to replace artificial mathematical attractions by activity propagated according to simple relations, this sentence may perhaps be taken as expressing his belief that in probing into the details of the dynamics of the unexplored molecules we are still practically confined to the partial but fruitful conception of mutual forces.

Thus in the appendix entitled "Aepinus Atomized," a definite foundation is postulated by taking the electrion to be a very minute negative ionic charge, and an atom to involve a positive ionic charge rigidly distributed through a much larger sphere, but in normal condition neutralised by one or more electrions inside it, which may be occasionally shot out as kathode rays; and electrions and atoms can be wholly or partially superposed in the same space without mutual deformation. On this basis the statical configurations of electrions in the spheres, that can represent neutral atoms, are discussed and are applied to the dielectric quality of matter and its æolotropy in crystals, to the intricate and elegant details of the pyroelectric and piezoelectric quality in the latter, and in more general terms to the nature of conduction and its striking relation to temperature, so different in pure metals and in non-metals and alloys. In further appendices the same conception is applied to crystalline dynamics, where auxiliary Boscovichian laws of pure attraction are also introduced, because Lord Kelvin thinks a purely electric basis is too narrow, even when not restricted to spherical nuclei as here. The whole is developed on all sides with marvellous directness and facility in tracing out crystalline groupings in space, which, however, make it difficult reading, though relieved by frequent flashes when a vivid analogue of some ascertained experimental relation appears. It is a conception such as this that Lord Kelvin has in mind in his postulate, above referred to, that material bodies are labile to optical compressional waves. The free molecular vibrations that must correspond to a bright line-spectrum do not come in for consideration; nor does the now burning question of actual dissociation in typical chemical atoms.

The task of making a review of a book like the present one can at best be very imperfectly executed. The book is largely a new creation. It surveys a vast range, all the cognate subjects on which the author feels that he has something new to communicate—laws of diffusion of gases, transparency of the sky, detailed dynamics of optical chirality, motion of molecules through æther, front of a wave-train in a dispersive medium, the finiteness of the universe, atomic theory of electricity, regelation and plasticity of ice, waves and ripples on water and their dispersion, crystalline structure and iridescence, partition of energy in molecular systems, crystalline dynamics on Boscovich's principles, electric and magnetic screens. Instead of putting the question, Is this subject clearly and strikingly expounded? one has rather to ask, Is this new departure or revolutionary idea justified by its results? Any off-hand decision is, of course, impossible. When one is in difficulty over inscrutable or irreconcilable phenomena, it will be a book to turn over to see what the premier authority has to say on the subject in hand; for what he says is not lightly thrown from his pen, it is the work of twenty years, and withal it forms a consistent whole. In the remarks here made about only a few of the many themes of which it treats, it is the obviously revolutionary element that has attracted attention. There is, however, one very serious criticism as to which there can be no question. This book of seven hundred pages—dealing in concise manner with nearly all the most intricate topics of dynamical and molecular theory, with the cross references and recurrences to previous passages that are involved in twenty years of preparation—is without an index, and the detailed table of contents does not meet the want. The thanks of the scientific world will surely go to the veteran author, now by a happy choice Chancellor of the university which he has so long adorned, for this splendid gift, which stimulates and educates even where it fails to convince, and bears on every page evidence of profound and unwearying thought.

J. L.

BLOOD RELATIONSHIPS.

Blood Immunity and Blood Relationship; a Demonstration of Certain Blood-relationships amongst Animals by Means of the Precipitin Test for Blood. By George H. F. Nuttall, M.A., M.D., Ph.D. Pp. 444. (Cambridge: University Press, 1904.)

TSCHISTOWITSCH was the first to observe that if a rabbit were subjected to repeated injections of serum from an animal of a different species, it reacted to the introduction of the foreign proteid by forming and accumulating in its blood a substance which, when added to a solution of the particular serum injected, gave rise to a precipitate. These experiments at once aroused considerable interest, and were confirmed and extended by a number of observers on account of their importance in relation to the processes whereby the organism protects itself against the introduction of proteid poisons and micro-organisms by the formation of so-called anti-bodies.

The interest of the observations is not, however, confined to the doctrine of immunity, for fuller knowledge of the phenomena has shown them to have important applications to both forensic medicine and zoology. The value to the former was pointed out by Uhlenhuth and others, who directed attention to the fact that the serum of an animal previously subjected to repeated injections of human serum forms a very sensitive test for the same, and can therefore be used for the detection of human blood. The importance of precipitin phenomena to the zoologist has been particularly insisted upon by Dr. Nuttall, and the present volume is largely concerned with results of interest from this point of view.

When the precipitins were first discovered, it was concluded that the reaction was strictly specific, and that the serum of an animal injected with human serum only formed precipitates with the serum of man, and one injected with ox-serum only when added to the serum of the ox. Nuttall and Uhlenhuth showed, however, that no such hard and fast line could be drawn. Indeed, the development of our knowledge of the specificity of the precipitin reaction is in great measure due to the work of Dr. Nuttall and to that of his pupils, Drs. Graham Smith and Sangar. However, although not strictly specific, a precipitin precipitates the serum of the same species of animal as that used in its preparation more readily and in greater amount than that of animals of other species, and the difference is least marked when the animals are closely related, as in the case of the horse and the donkey. From these results, Dr. Nuttall conjectured that the varying degree to which a precipitin reaction occurred might afford a valuable indication as to blood relationship.

The present volume contains the results of experiments, undertaken by the author in conjunction with Drs. Graham Smith and Sangar, with a large number of anti-sera upon the blood of 586 different species of animals.

The book is divided into two parts. Part i. is devoted to a condensed summary of our knowledge on anti-bodies in general. It commences with a brief but clear account of Ehrlich's theory regarding the formation of anti-toxins and anti-bodies generally. This is followed by a series of paragraphs on ferments and anti-ferments, cytotoxins, hæmolysins, bacteriolysins, agglutinins, &c., which in style suggests the pages of a technological dictionary. Short sentences, each pregnant with some fact, and with reference attached, follow one another in bewildering succession. Many of these are contradictory, and it is to be regretted that there is no summing up by the author at the end of each paragraph.

This portion of the book does great credit to the author's industry and scholarship, but it makes impossible reading, and is only serviceable to one knowing the subject and wanting the references. After fifty pages one is glad to reach the end of part i., and to come to the subject-matter proper of the book, viz. the precipitins.

Part ii. commences with the methods for obtaining precipitating anti-sera. The style now leaves little to be desired, and this account is delightfully clear and complete, so that anyone wishing to repeat the experiments could hardly fail for want of adequate instructions. Sections ii. and iii. contain nearly all that is known of the nature of precipitin reactions and the effects of heat, peptic and tryptic digestion, filtration and putrefaction, upon both precipitins and precipitable substances. On p. 126, however, the statement is made that "no measurements of the amount of precipitin during the growth of immunisation have as yet been made which would correspond to those made upon antitoxin." One can only presume that this paragraph was written prior to the publication of von Dungern's quantitative experiments with the precipitins obtained by the injection of crab-plasma.

Section iv. deals with the specificity of the precipitins. After historically reviewing the views of different experimenters on this subject, and showing that increased knowledge has fully confirmed his earlier contentions against the absolute specificity of precipitin reactions, the author expresses himself as in entire agreement with the remark of Linoisier and Lemoiné: "Là où on a cru voir une action spécifique, un examen attentif ne permit de voir qu'une action particulièrement intense."

Section v. treats of precipitins obtained by the injection of other proteids from bacteria, milk, and higher plants. In section vi. are given in tabular form the results of 16,000 tests of 30 anti-sera with the bloods of a large number of animals. This particular series is not quantitative, and was presumably made before the author had devised his quantitative method, the reactions being entered as "full," "marked," "medium," "faint," and "nil." This is followed by a later series of 500 experiments made in conjunction with Strangeways with a quantitative method devised by the author, whereby the dilution of the serum and the time of reaction being constant, the actual volume of the conglomerated precipitate is measured in an ingenious way. The volume of the precipitate, with the homologous serum, is taken as the unit, and the volumes obtained with the sera of other animals are expressed in percentages of this unit.

The method and the interest of the facts brought to light by it will be clearer from two short examples.

Amount of precipitate obtained by adding anti-human serum to the serum of man and apes (expressed as percentages):—

Man	100
Ourang	80
Cynocephalus mormon	50
Cercopithecus petaurista	50
Ateles vellerosus	25

Amount of precipitate obtained in a similar way by adding anti-horse serum to the serum of horse, donkey, zebra:—

Equus caballus	100
Equus asinus	84
Equus grevyi	58

Tested in this way the indications of blood relationship between man and the ourang are comparable to those between the horse and the donkey. The serum of other mammalia gave but traces of precipitate with the above anti-sera, and that of other vertebrates none at all.

In these precipitin-phenomena we have perhaps a really physiological test of blood relationship, and that, as the author suggests, "a common property has persisted throughout the ages which have elapsed during the evolution of animals from a common ancestor in spite of differences of food and habits of life." Anomalies do undoubtedly occur when working with any particular anti-serum, so that all conclusions must be controlled by experiments with anti-sera prepared from different individuals. Section viii. contains the results of 2500 similar tests, undertaken by Graham Smith, in the application of the method to the lower vertebrates and invertebrates. These will be of no less interest to zoologists, but space prevents our entering upon further particulars.

The ninth and last section deals with the practical application of precipitin reactions to legal medicine. As the precipitable substance in sera is a relatively stable body, is very resistant to the action of putrefactive organisms, and is not destroyed by drying, the detection of human blood by this means is not confined to stains of recent origin. Indeed, Graham Smith and Sangar have examined a large number of articles from the collection of the Criminal Investigation Department, Scotland Yard, and have succeeded in identifying human blood stains which were thirty years old.

The fact that anti-human serum forms precipitates to some extent when added to the serum of monkeys does not seriously diminish the forensic value of the precipitin test for human blood, for the plea that suspected bloodstains were of simian origin would seldom be raised and hardly ever substantiated.

The volume concludes with an excellent bibliography on precipitins and allied subjects which occupies sixteen pages!

In addition to containing the methods and experimental results whereby the author and his associates, Drs. Graham Smith and Sangar, have tested and developed the precipitin reaction as an indication of blood relationship, the book contains practically all that is known on the subject of precipitins up to the present time, and will therefore be indispensable to anyone desiring to become acquainted with or to work upon this subject.

CHARLES J. MARTIN.

THE MOON.

The Moon. A Summary of the Existing Knowledge of our Satellite, with a Complete Photographic Atlas. By Wm. H. Pickering. Pp. xii+102; 100 illustrations. (New York: Doubleday, Page and Co., 1903.) Price 10 dollars net.

IT has so long been taught that the moon is a world on which nothing ever happens that it may come as a surprise to many to learn that the probability of frequent changes in the lunar surface is now seriously advocated. The author of this book, who is a well known American astronomer, is convinced that there are daily alterations over small areas which cannot be explained either by shifting shadows or varying librations, and therefore infers that there are real changes in the surface detail. The observations on which this conclusion is based are collected in the present volume, which also includes a more general account of our satellite, and contains the first complete photographic atlas which has yet been published.[1]

To make a thorough study of the moon, Prof. Pickering some years ago suggested the use of a telescope of great focal length, and, as so frequently happens in America in such circumstances, the generosity of two anonymous donors enabled him to try the experiment. The instrument actually employed was a 12-inch objective of 135 feet focal length, giving a direct image of the moon nearly 16 inches in diameter, and to obtain the advantage of such "steady" atmospheres as can only be found in low latitudes it was taken out to Jamaica and set up at Mandeville, 2080 feet above sea-level. The long telescope tube was erected on the side of a convenient hill with its axis in the direction of the pole, and light was reflected into it at the lower end by a clock-driven mirror. The instrument was so far successful that all the negatives for the atlas were obtained within seven months.

The atlas shows the lunar surface in sixteen sections, each of which is exhibited under five different conditions of illumination, and there is in addition a good picture of the full moon, with the necessary key maps, besides other illustrations of interest. Although the photographs are not all of the finest definition, the completeness of the series gives them a special value, and the atlas will doubtless prove extremely useful to all who are engaged in lunar studies.

Apart from the photographs, the chief interest of the book lies in the observations and arguments which are put forward in favour of lunar activities. The moon is so near that no improbably great area need be affected to make a change visible to an observer on the earth, but any real variations are liable to be

[1] The atlas is also published in the *Annals* of the Harvard Observatory, vol. li, 1903.

masked by the varying conditions of illumination. This difficulty does not, of course, disappear even when series of photographs are under examination; in the words of the author (p. 91):—

"It was soon found that for certain regions, notably those in the northern half of the disc, the change in appearance produced by the difference of lighting rendered it absolutely impossible to identify the same formation upon the plates taken at (lunar) sunrise and sunset and those taken at noon."

Photographs at intermediate phases were accordingly taken, and by aid of these the connection can be traced.

Photographs, indeed, introduce another difficulty. Slight changes in exposure and development were found sometimes to produce very misleading results, and it is pointed out that the only safe procedure is to confirm all suspected changes by extended observations under different conditions with the telescope. There is, however, no reason to suppose that the author is unfamiliar with the many pitfalls, and the interesting results of his labours may therefore be received with some confidence, or at least as demanding careful investigation by other observers.

Attention was directed by the author ten years ago to the variability of many of the dark spots which are dotted over the lunar surface, the three in Alphonsus being probably familiar to most observers. The view then expressed that these are patches of organic growth resembling vegetation, which spring up and die during the long lunar day, still seems to give the only simple explanation of the appearances observed. The spots are said to be darkest near full moon, when shadows are geometrically impossible, and a real change in the reflecting surface therefore seems to be highly probable.

On the question of active lunar craters, the chief facts relating to Plato and the much discussed case of Linné are summarised, and an account is given of phenomena observed in the crater forming the source of Schroter's valley which bear a striking resemblance to those accompanying the active eruption of a terrestrial volcano. Part of the description reads:—

"Dense clouds of white vapour were apparently rising from its bottom and pouring over its south-western crater wall in the direction of Herodotus" (p. 40).

The changes in this "vapour column" are said to be visible with a 6-inch telescope under ordinary atmospheric conditions, so that the reality of the phenomenon need not long remain in doubt, whatever explanation may be adopted. The author evidently believes that there is an actual emission of vapour, and he points out that as water cannot exist as a liquid on account of the rarity of the lunar atmosphere, it would take the form of snow or hoar frost.

Many of the changing appearances of lunar details are, in fact, attributed to deposits of snow and hoar frost which melt under the influence of the sun's rays, and are re-deposited when those rays are withdrawn. Among other evidence that there is snow on the moon, two photographs of the full moon are reproduced, one representing it as ordinarily seen, while the other is intended to exhibit the principal snow-covered areas; as these are differently printed copies from the same negative, the illustration is anything but convincing in the absence of details as to the printing processes. Other examples are more satisfactory. Linné, for instance, is surrounded by a white halo, which is stated to be not only now permanently smaller than it was thirty years ago, but to change with the altitude of the sun in a manner analogous to the seasonal variations of the polar caps of Mars. In this case the author had the happy thought to inquire if there were any variation during a lunar eclipse, the idea being that the withdrawal of sunshine for a couple of hours or so might produce an appreciable increase in size. Such an enlargement appears to have been established at the Lowell Observatory in 1898, and by the author himself in 1899, 1902, and 1903; another observer, Mr. Saunder, however, seems to have been somewhat doubtful as to the reality of the slight increase which his measures indicated in the eclipse of 1903, and as his observations would make the halo twice as great as those which the author made on the same occasion, further observations of this kind are evidently desirable.

It is also considered probable that many of the remarkable changes which have long been recognised in the craters Messier and Messier A are to be accounted for by varying depositions of snow.

Permanent deposits of snow in the craters themselves are believed to furnish an adequate explanation of the striking brightness of such craters as Aristarchus, and even the long bright streaks, such as those which radiate from Tycho, are attributed to the same substance. The long streaks are considered to be composed of a multitude of smaller snow streaks issuing from small white craterlets, usually less than a mile in diameter, many of which show a tendency to occur along lines which are probably cracks or lines of weakness in the lunar surface.

The "riverbeds" and lunar "canals," which the author has detected, present many features of interest, and the latter may be of special importance in view of the light which they may throw on the nature of the corresponding features of the planet Mars.

While some of his researches tend to modify the prevalent idea that the moon is a dead world, the author has no revolutionary views to put forward as to the general character of the lunar formations. He says:—

"There seems, indeed, to be no feature found upon the moon which is not presented by the Hawaiian volcanoes, and there is no feature of the volcanoes that does not also have its counterpart uuon the moon. Even the cause of the bright streaks upon the moon . . . is partly illustrated by Hawaii" (p. 25).

Sufficient has been said to indicate the interesting character of this work, but its value as a contribution to science can scarcely be gauged until independent observations of the unexpected phenomena have been made. It is fortunate that some of the investigations suggested are within range of very modest instruments, even as low as 4 inches aperture.

KINSHIP AND MARRIAGE.

Kinship and Marriage in Early Arabia. By the late W. Robertson Smith. New Edition, with Additional Notes by the Author and by Prof. I. Goldziher, Budapest. Edited by Stanley A. Cook, M.A. Pp. xxii + 324. (London: A. and C. Black, 1903.) Price 10*s.* 6*d.*

THIS new edition of a masterly work should be welcomed by all who take an interest in the study of primitive man, a study which, it is no paradox to say, has more practical bearing than academic history on the social problems of the future. Before his death Robertson Smith made corrections and added notes to the first edition of 1885, which are now incorporated. As anthropologists and orientalists know, the essay is an application of the theories of J. F. McLennan to early Arabia, conducted with the originality, insight, logical clearness and brilliance of exposition which are inseparable from the name of Robertson Smith.

Beginning with an exposure of the easy methods of the Arabian genealogists, he proceeds to argue that "female kinship" was once the rule. The strong Arab sense of blood-unity "can only have come from female kinship" and from a state of society where children were reckoned to the tribal kin, but not to a particular father. He regards the *mota* marriages, common in the time of Mohammed, as a last relic of McLennan's *beena* marriage, in which the husband goes to live with his wife's people. This system of *beena* or *sadica* marriage with female kinship and totemism was broken up by the growth of the idea of the family (*dar*), the result being male kinship and *baal* marriage, in which the husband has "dominion." The change was made through "marriage by capture," followed by marriage by purchase. But there is also to be explained the acceptance of male kinship in a state of society where there was "no notion that a man should keep his wife strictly to himself." The only possible explanation lies, the author thinks, in Tibetan polyandry, in which a group of brothers bring to their common home a common wife. This must have been preceded by Nair polyandry, in which a group of brothers is entertained in her home by a common wife. The whole doctrine of the paternal system implies that this polyandry was quite widely spread. Lastly, bars to marriage before Islam were made on female kinship alone; the early Arabians and northern Semites possessed totemism and exogamy.

How far the author might have modified his conclusions is an idle speculation. Criticism of one who has taught us all is especially invidious in the case of a book which in substance is nearly twenty years old. But it is only fair to science to point out that recent research has found grave objections to McLennan's theory of social development and to many of his "universal institutions" themselves. Much also of McLennan's evidence was bad; the author quotes (p. 98) one of his examples of "marriage by capture," which is nothing of the kind. The best authorities contradict the statement on p. 262 as to the prevalence of such "marriage" in Australia, and that on p. 267 as to "marriage by capture" being followed by exogamy. Objections may be raised to the suggestion that *beena* marriage with adoption into the woman's kin are proved by Genesis ii. 24—"a man shall leave his father and mother and shall cleave unto his wife, and they two shall be one flesh"; to the old idea that early man considered animals to be men in disguise; to the view that the Arabs "practised" cannibalism, and that "promiscuous" behaviour at religious feasts is a survival of polyandry; and to the acceptance of metronyms in the genealogies as proofs of female kinship, while patronyms are rejected.

Recent speculation, however, is but beginning to reconstruct the development of the primitive social organism. The great value of this book is to prove that the early Semites followed the same lines of development, whatever they were, as other races, and to provide the best exposition of the prevalent theory.

ERNEST CRAWLEY.

SYLVICULTURE.

Schlich's Manual of Forestry. Vol. ii. Sylviculture. Third edition. Pp. viii + 393. (London: Bradbury, Agnew and Co., Ltd., 1904.) Price 8*s.* net.

IN NATURE of July 23, 1891 (vol. xliv. p. 265), Sir Dietrich Brandis, K.C.I.E., reviewed the first edition of the above volume. He then prophesied a great future for Prof. Schlich's work. That the prophecy was not a vain one has been amply proved by the test of time. The book reached the second edition in 1897, and has now passed into the third. There is no preface to this edition, but the arrangement of the former editions has, on the whole, been retained; however, the subject-matter has been somewhat differently classified. The present volume consists of four parts—each part is divided into chapters and sections, which are further subdivided as occasion demands. Part i. deals with the foundations of sylviculture—this was formerly part iv. of vol. i. of the "Manual." Part ii. comprises the formation and regeneration of woods. Part iii. is devoted to the tending of woods, while part iv. consists of sylvicultural notes on British forest trees.

The author has condensed a marvellous amount of information into a small space. At the same time, each subject is dealt with at sufficient length to be quite intelligible to the student and practical forester. This is largely due to the admirable way in which Prof. Schlich has arranged his matter. One subject leads on quite naturally to another, so that there is no needless repetition and overlapping.

The author assumes that the student has already made some progress in other branches of science upon which sylviculture depends—"the forester requires to be well acquainted with the manner in which soil and climate act on forest vegetation, in order to decide in each case which species and method of treatment are best adapted, under a given set of conditions, to yield the most favourable results. The detailed consideration of the laws which govern this branch of forestry finds a place in the auxiliary sciences, such as physics, chemistry, meteorology, mineralogy and geology." Why not botany? especially plant physiology, the *bed-rock* upon which true scientific sylviculture must be founded. It has been for long a criti-

cism of foresters in this country that they are insufficiently acquainted with the life and form of plants —with botany, in fact—and the pages of this book seem to justify the criticism, at least there is occasionally a looseness of expression regarding botanical points which should not appear in a manual for students such as this. Take, for instance, the statement, "the atmosphere overlying the soil furnishes certain nourishing substances—heat, light and moisture" (p. 7), or again, "certain plants (Leguminosæ) can take nitrogen direct from the air by means of tubercles or nodules" (p. 11). The mention of the name Acacia up to p. 52 of the book instead of False-Acacia is botanically wrong and misleading, and the statement that elm does not ripen its seed in the north of England (p. 66) is also wrong because botanically unqualified. The identification of mistletoe with *Loranthus europoeus* (p. 324) is, we take it, a slip.

As regards sylviculture the book has been entirely brought up to date, and is eminently practical and suggestive. It may, with every confidence, be warmly recommended alike to the student, landed proprietor, forester and nurseryman. All doubtful or controversial matter has been carefully avoided, and every view stated, or method recommended, is founded upon the author's own direct observation and experience, as well as on that of others.

The various sylvicultural systems are clearly and concisely described, and their advantages and disadvantages amply criticised, so that the forester need have no difficulty in choosing the one best suited to his own locality and the objects of management. In the important sections dealing with the raising of plants in the nursery, much valuable and useful advice is given. The ultimate success of a wood depends, to a large extent, upon the health and vigour of the plants from which it originated—hence it is very important that young seedlings should be grown and handled with the greatest possible care. On p. 191, Prof. Schlich gives a timely warning to nurserymen in regard to the pernicious practice of laying down seedlings, when they are pricked out, into shallow trenches, involving the bending of the root-system to one side—a defect from which the tree does not recover for many years. He says, "unless nurserymen give up that vicious practice they must be prepared to see landed proprietors revert to the system of home nurseries."

Part iv. of the volume is replete with information. In fact, it is a condensed volume on sylviculture in itself. The notes on the Douglas Fir have been considerably extended, but in regard to the fungus enemies of this species, *Phoma Douglasii* might have been included, as this disease has been known in Scotland now for several years.

ENGINEERING IN SOUTH AFRICA.

The Engineer in South Africa. By Stafford Ransome, M.Inst.C.E. Pp. xx+319. (Westminster: Archibald Constable and Co., Ltd., 1903.) Price 7*s.* 6*d.*

AT the close of the war the author was appointed by the *Engineer* to visit all the British possessions in Africa south of the Zambesi River, and to write frankly and fully to that journal on the various problems which have been evolved by recent events. The result was a series of articles on "South Africa from an Engineer's Point of View." These articles were of a highly interesting nature, and were much appreciated at the time.

The volume before us combines the most interesting portions of these articles with much additional matter as well as most of the illustrations. Mr. Ransome is well known as a successful author of books of this type, and we are not surprised at the able way he handles the subject.

Any man seriously thinking of going to South Africa, be he an artisan or a trained engineer, should most certainly obtain a copy of this book; the information given on the cost of living and travelling, as well as on the prospects of employment, is very much to the point.

Chapter vi. deals with the labour question, a subject very much to the fore at the present time. Our author, after pointing out the prohibitive cost of white unskilled labour, discusses three alternatives, which are as follows:—(1) the importation of Asiatic labour; (2) the trusting to Providence to induce the Kaffir to work; (3) the taking of measures to make the Kaffir work, his conclusion being that the third alternative should be adopted, and that legislation should be introduced to this end. Chapter xiii. deals with the theory and practice of the railways, one of the most interesting in the book. The railway mileage at present open for traffic is 5457, under construction 2636, making a total of 8093 miles. Our author has much to say about the long delivery and high prices paid for railway plant when ordered in Britain, and no doubt has formed these views from conversations with men on the spot; he also compares American delivery of such material to our detriment. It is only fair to point out that the average locomotive built in Britain for these railways is the most expensive of its kind; its design usually emanates from the colony, and the locomotive builder here has to do what he is told. On the other hand, the American locomotive builder works with a much freer hand in every way. He supplies what he thinks best, and is not handicapped by a rigid specification; no wonder he can deliver sooner!

Judging from chapter xiv., the harbours of British South Africa are in a bad way, more especially those in Cape Colony, where for political reasons their development has been remarkably slow; and the author very reasonably argues that since the majority of imports are likely to be for the Transvaal, the harbours further up the coast are more likely to develop in the future; this applies to the Port of Natal, Durban.

Mr. Ransome gives us an excellent description of diamond mining in Kimberley in chapter xvi., tracing the development of the De Beers Company from the commencement, and explaining the various methods from beginning to end, and the same can be said of chapter xvii., which has for its subject "Underground at the Rand Mines."

This volume is of interest to all connected with South Africa, and Mr. Ransome may be congratulated on the production of so excellent a book.

N. J. L.

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THE MANUFACTURE OF

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AND

LABORATORY FURNITURE

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These extensive premises have been designed and built by this enterprising firm to

EXTERIOR OF MANUFACTORY.

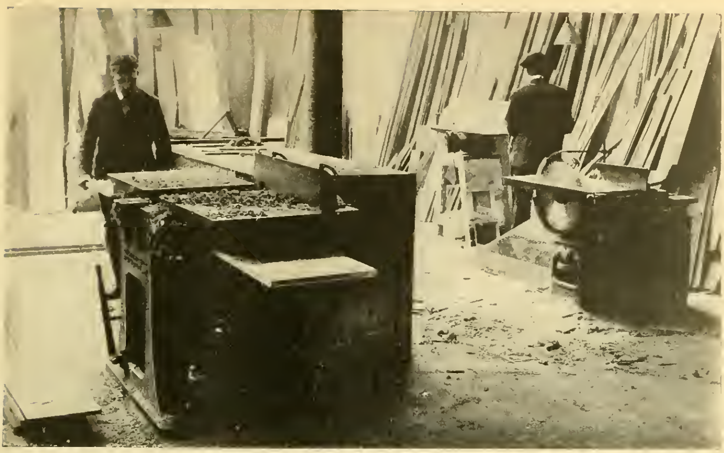
give them up-to-date premises for the manufacture of all the Apparatus (except glass) required in connection with **Technical Education,** and for making the **Laboratory Furniture** for which they are also so well known.

The buildings, which lie back from the street, are built in a substantial manner, have a frontage of 60 feet, and are lighted and ventilated upon the most improved principles. An ingenious use is made of the fall in road level, the ground floor being at the same level as the higher portion, allowing a loading and unloading deck, this being most useful for receiving timber and loading the finished fittings to the railway

PART OF WOODWORKING SHOP FOR LABORATORY FURNITURE.

wagon. The **Ground Floor,** which is devoted to **Wood Working,** is **60 feet long,** and with the extensions for Machinery has a total width of **74 feet**, so arranged that a good light is obtained all day.

In this shop **Laboratory Fittings** are manufactured throughout from the rough timber to the finished Bench, Fume Chamber, Lecture Table, &c., and here may be seen Benches and other fittings of the best workmanship possible. A close examination of some of these in course of construction proved to us that the finish of the interior was equal to that of the exterior in every respect, and from the way the joints and other parts were made we could see at once how it is that this firm have built up such a good reputation.



PART OF WOOD MACHINE SHOP.

PART OF WOOD MACHINE SHOP.

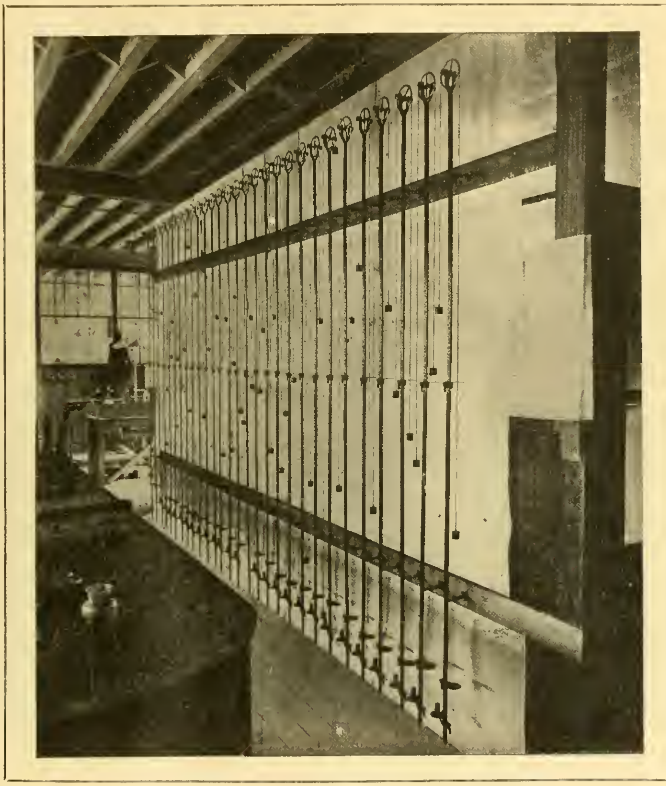
One most important point is that purchasers can inspect the Fittings whilst being made, satisfying themselves that everything is in accordance with the specification, in respect of workmanship and material being of the very best, and of full size details. In these shops are to be seen some fine stocks of Teak, Pitch Pine, &c., and here, to ensure material for the particular part in hand being of the right kind, the wood is specially selected for each job; and in the case of teak tops particularly, wide planks are used to ensure a minimum number of joints, which, however, when made as this firm make them, in our opinion, cannot possibly open. When a job is commenced the

DELICATE INSTRUMENT SHOP.

wood is first selected, care being taken to use nothing but well seasoned stuff; it is then sawn to the desired lengths, put through the planing machine (one of which, a self-feeder, will plane 18 inches wide and 6 inches thick); it is then machined according to what part of the bench, &c., it is intended for, and fitted together to form the desired piece of furniture by men who, being always engaged on this class of work, are really experts at it.

A portion of the works has been set apart for the manufacture of the smaller class of Woodwork, such as **Electrical Machines,** Balance Cases, **Resistance Boxes,** Gas Analysis Apparatus, &c., &c. **Machines** for Sawing, Planing, Mortising, Tenoning, Shooting, Sand-papering, Slotting, Grooving, Moulding, Surfacing, Turning, Thicknessing,

&c., may here be seen at work; these are driven from a line of main shafting extending the whole length of the basement under the machine shop. The motive power is supplied by a 50 H.P. Gas Engine, with extra heavy fly-wheels, built specially for this firm. This engine also drives a dynamo fitted with fly-wheel which supplies the electricity to run



A BATCH OF ATWOOD MACHINES READY TO BE TESTED.

electric motors for driving the machinery in positions to which it is difficult to take power from the main shaft, and also to light the whole of the building.

On the **First Floor** we find a goodly array of Foot Lathes, Vices, and Work Benches for the manufacture of the **finest Scientific Instruments,** such as Resistances, Wimshurst Machines, Atwood Machines, Galvanometers of all sorts, Aluminium Pulleys, Thermopiles, Optical Benches, Melloni's Apparatus, Polarimeters, Spectrometers, Microscopes, &c., &c.; also a Dark Room with electrical current from the main dynamo for testing Arc Lamps,

charging Accumulators, X-Ray work, &c., and testing appliances for the adjustment of instruments generally.

Pattern Room, fitted with receptacles for their costly and multitudinous patterns; and also **Wood Polishing Room.**

The Machinery on the **next floor** is driven by two motors connected through automatic overload cut-out switches to the main dynamo. This floor is devoted to the manufacture of the **heavier Brass, Iron, &c.,** such as Retort Stands, Clamps, Crucible Tongs, Tripods, Levelling Screws for apparatus, Bunsen Burners, Triangles, Taps, Bench Uprights, and all the commoner class of apparatus.

HEAVY METAL WORKING SHOP.

Power Lathes of various forms are used according to the work required; Disc Emery Plate for squaring, edging, shaping, &c., may be seen at work, and driven from a separate motor; Polishing Spindles, fitted to which are pipes taking away by means of an exhaust fan the dust from the mops (this fan also draws air away from the wood polishing shop below, keeping the atmosphere pure); Forge, Soldering Hearths, are evidences of the class of work done, and a row of Presses shows that P. H. & Co. are alive to the possibilities of cheapening apparatus by this means. An Atwood's Machine is a good example of the above: whereas a few years ago such a machine cost about £12, and even at this price was hardly accurate, now a machine at 30*s*. has just been put on the

market by this firm which gives most satisfactory results. This has been protected by patent; it is a modification of the pattern which was first originally made by them, and which they still sell at £4 15*s.* 0*d.*

Lacquering is done on this floor in a room set apart for the purpose. A flat roof serves the purpose of a store for Laboratory Sinks, Receivers, &c., of which a large stock is always kept.

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SOME OF THE STAFF.

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Messrs. Philip Harris & Co., Ltd., still have their Warehouses and Show Rooms at 144 and 146 Edmund Street, Birmingham, and 179 Great Brunswick Street, Dublin and recently extensive alterations and additions have been made, to enable them to keep a larger and more varied stock than before.

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